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	Place.	Population.
	Alta	20
1	Alameda	25,000
2	Albany	800
	Amador City	200
	Adams John	25
	Alto	25
5	Auburn	2,375
	Agua Caliente	100
	Alvarado	900
	Antioch	3,000
2	Barber	500
2	Belmont	350
	Belvedere	1,000
	Benicia	3,360
2	Beresford	25
2	Berkeley	40,000
	Biggs	750
	Big Oak Flat	20
	Brentwood	200
	Broderick	200
	Brown's Valley	50
	Byron	200
2	Burlingame	4,000
	California City	25
	Campbell	600
	Centerville	1,000
	Centerville	20
2	Chico	13,000
2	Colma	3,500
2	Colusa	1,500
	Concord	1,500
	Cement	1,500
5	Colfax	500
	Cordelia	150
	Corte Madero	350
	Crockett	2,500
	Crow's Landing	375
	Daly City	25
	Davis	750
	Decoto	350
	de Sabla	25
5	Dixon	1,000

	Place.	Population.
	Dobbins	50
	Davenport	1,000
	Drytown	20
	Durham	500
	Dutch Flat	500
2	Easton	300
2	East San Jose	1,660
	Eagle's Nest	50
	Elmira	150
	El Verano	400
2	Emeryville	5,000
	Encinal	100
	Fairfield	834
	Forestville	100
1	Fresno	30,000
2	Fair Oaks	250
	Folsom	1,800
	Glen Ellen	500
3	Grass Valley	4,500
	Gridley	1,800
	Groveland	25
	Guerneville	500
	Hammonton	500
2	Hayward	4,000
2	Hillsborough	1,000
	Ignacio	100
	Ione	900
	Irvington	1,000
	Jackson Gate	20
	Jackson	2,035
	Kennedy Flat	20
2	Kentfield	250
	Knight's Landing	350
	Lake Francis	5
	Lathrop	300
	Live Oak	200
	Livermore	2,250
	Los Gatos	3,000
	Larkspur	600
	Lincoln	1,400
2	Lomita	100

	Place.	Population.
	Los Altos	500
5	Loomis	400
	Martinez	5,000
	Martell	150
2	Marysville	7,000
	Mayfield	1,500
2	Menlo Park	1,500
	Meridian	300
2	Millbrae	300
	Mill Valley	2,500
	Mission San Jose	500
	Mokelumne Hill	150
	Monte Rio	50
	Mountain View	2,500
	Mare Island	500
2	Napa	7,000
3	Nevada City	2,700
	New Chicago	10
	Newark	700
5	Newcastle	750
	Newman	1,000
	Niles	800
	Novato	250
2	Oakland	230,000
2	Palo Alto	6,300
	Pacheco	200
	Penryn	250
2	Petaluma	5,500
2	Piedmont	1,720
	Pinole	1,500
	Pittsburg	2,372
	Pleasanton	2,000
	Point San Pedro	20
	Port Costa	600
2	Redwood City	3,200
2	Richmond	10,000
	Rio Vista	884
5	Rocklin	1,000
5	Roseville	2,600
	Rodeo	500
2	Ross	500

	Place.	Population.
4	Sacramento	60,000
	San Andreas	200
2	San Anselmo	1,500
2	San Bruno	1,500
2	San Carlos	100
2	San Francisco	416,912
2	San Jose	30,000
2	San Leandro	4,000
	San Lorenzo	100
2	San Mateo	6,500
2	San Quentin	2,500
2	San Rafael	6,000
	San Pablo	1,000
	Santa Clara	6,000
	Saratoga	50
2	Santa Rosa	12,000
2	Sebastopol	1,200
	Sausalito	2,500
	Smartsville	500
2	So. San Francisco	2,500
2	StanfordUniversity	2,600
	Sonoma	1,200
	Stege	1,000
5	Stockton	30,000
	Suisun	1,200
	Sutter Creek	1,500
	Sunnyvale	1,500
	Tiburon	400
	Tormey	20
	Towle	100
	Tracy	1,200
	Vacaville	1,200
2	Vallejo	15,000
	Walnut Creek	350
	Warm Springs	200
	Wheatland	1,400
	Winters	1,200
2	Woodland	3,200
	Yolo	400
2	Yuba City	1,200
	Total	1,104,977

Unmarked—Electricity only. 1—Gas only. 2—Gas and Electricity. 3—Gas, Electricity and Water. 4—Gas, Electricity and Street Railways. 5—Electricity and Water.

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POWER AND GAS
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THE OAKLAND AND ANTIOCH RAILWAY

The census statistics of 1910 gave the population of the Bay Cities of California as 653,449 and that of Sacramento with its tributary district a population of 63,696. It is not surprising, then, that the opportunity to interlink by an electric transportation system these districts, which comprise a population of nearly three-quarters of a million people, should have been developed by local capitalists during the past year.

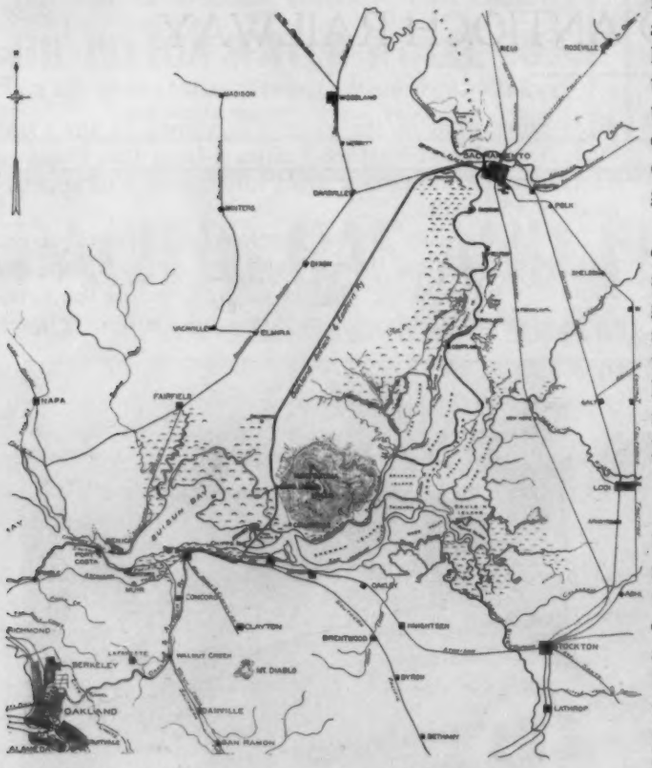
Bay Point Station Showing Type of Car.

By reference to the map shown herewith it is seen that the Oakland and Antioch is projected to connect with the Key Route system at Fortieth street and Shafter avenue in Oakland. To the east and north of Oakland the railroad opens up a hitherto secluded but fertile territory, comprising the hamlets of Lafayette, Walnut Creek, Concord and Bay Point. The latter city is the eastern terminus of the Oakland and Antioch Railroad. Recently an extension from Bay Point to Sacramento has been undertaken. While closely affiliated with the Oakland and Antioch, this extension comprises a separate corporation and is known as the Oakland, Antioch and Eastern Railway. The Oakland and Antioch Railway comprises a main line distance of 31 miles, that of the extension known as the Oakland, Antioch and Eastern Railway, from Bay Point to Sacramento, comprises a main line distance of approximately 53.5 miles.

From the Key Route junction at Fortieth street and Shafter avenue, the Oakland and Antioch runs for about 1½ miles along Shafter avenue, one of the principal residential streets in Oakland, and continues thence for at least another mile through one of the best new villa districts of the city. Between this villa district and the tunnel at the summit of the grade, the line extends for about three miles additional. At the summit in the Contra Costa hills a tunnel 3200 ft. in length is being driven to cut the crest of the ridge. From the eastern portal of the tunnel, the line gradually descends into the wide and fertile Mauraga Valley and then it continues on easy grades to its final terminus at Bay Point. That portion between Bay Point and Walnut Creek was put in commercial operation about six months ago.

The Oakland, Antioch and Eastern Railway proceeds from Bay Point to Sacramento and in doing so

extends easterly about 6.6 miles along the south shore of Suisun Bay to a point where a convenient and economical crossing may be effected at an arm on San Francisco Bay. This crossing is made from a point on the south shore about 1½ miles west of Pittsburg, formerly known as Black Diamond. The landing on the north shore is on Chipp's Island. The crossing is a short distance below the confluence of the Sacramento and San Joaquin rivers. The width of the water way is about 3000 ft. The railway trains are to be transferred by ferry. On the north side of Suisun Bay crossing, the Oakland, Antioch and Eastern Railway location lies on tide or marsh lands for about four miles, crossing Chipp's Island and Van Sickle Island to the westerly edge of the Montezuma hills. The two islands are separated from each other and from the main land by narrow sloughs, one of which is navigable and over which will be constructed a drawbridge of about 100 ft. span.



Map of Oakland and Antioch and Oakland, Antioch and Eastern Railways.

The railway location skirts along the westerly edge of the Montezuma hills by means of a grade not exceeding 0.5 per cent to the Montezuma summit. Thence it descends on a gentle grade to a plain at the foot of the hills near Denverton. From this point on, the located line is to finally cross to the east side of the Sacramento River by means of the Northern Electric Railway bridge, and then enter the heart of Sacramento.

Physical Characteristics.

Beginning at the intersection of Fortieth street and Shafter avenue in the city of Oakland, the Oakland and Antioch Railway climbs a continuous grade to the tunnel above mentioned. The sharpest curve in the construction is 12 degs. 30 min., and is at a point in the hills between Oakland and the summit tunnel. This curve is shown in the heavy cut work illustrated. Aside from this maximum, 10 deg. is the sharpest curve on the first twenty miles and 8 deg. in the valley section below Walnut Creek. For the first 5000 ft. near Shafter avenue the grade is 4.6 per cent compensated, and for the balance of three miles to the summit tunnel, 2.6 per cent compensated. The summit tunnel is 3200 ft. in length and is on a 2 per cent grade descending in the direction of Bay Point. In the descent from the tunnel to the easterly valleys there are also a few short grades, but these are all within the maximum before mentioned, that is, 2.6 per cent compensated for east-bound, and 2 per cent compensated for west-bound traffic.

At the lower end of the valley near Bay Point there is a temporary minor summit with a 3 per cent grade on each side over which trains are now operating. On the 4.6 per cent grade near the Oakland yard a pusher service is to be utilized in the case of the heavier trains, although the lighter trains are expected to operate without pushers, but at slow speed. The topography of the district near Shafter avenue admits of a location having 2.6 per cent grade and at a later date the heavier grade will be eliminated and the latter grade substituted.

All the large culverts on the Oakland and Antioch are of reinforced concrete. In the Walnut Creek section, which is now in operation, there are two plate girded bridges, one of 44½ feet and the other of 54 ft. span. The track is 70-pound rail, rock ballasted. On the 12 miles at the easterly end, 40-pound rails were laid at first, but these are being replaced with 70-pound rails, while this lighter material is being placed in the yard tracks and sidings.

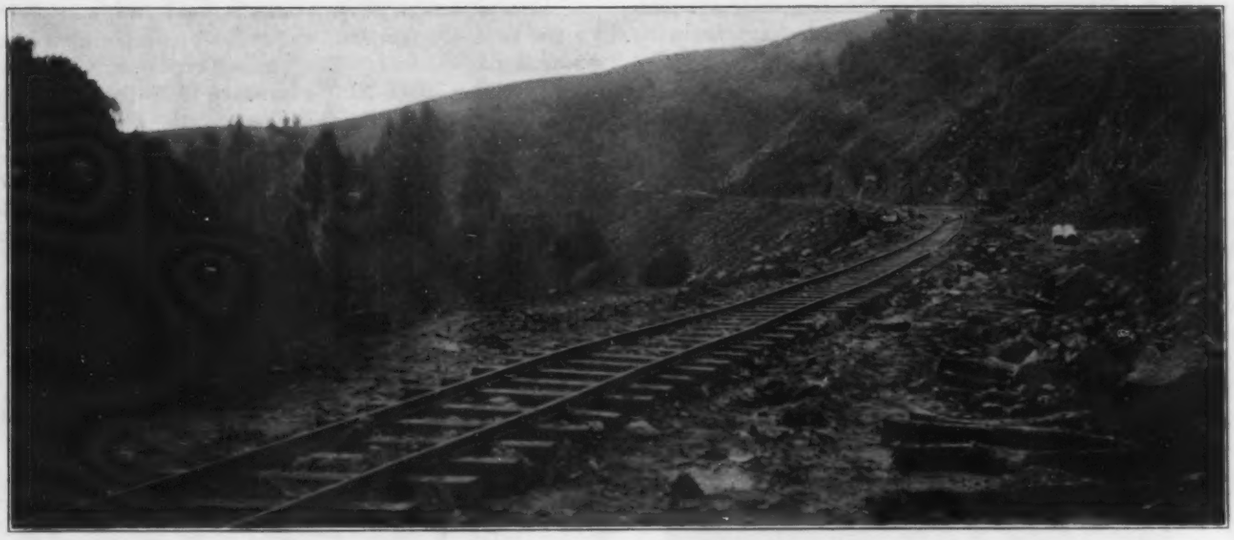
Voltage and Overhead Construction.

The operation is by 1200-volt d.c. overhead trolley, bracket construction, with 0000 trolley wire and the necessary feeders and transmission. Power is bought from the Great Western Power Company, whose lines cross the Oakland and Antioch or pass very closely to it at many points. The substation at Concord is of 600 kw. capacity and in the early future will be increased to 1050 kw. There is another substation at the east portal of the tunnel. Near the Concord station is a temporary carbarn, repair shop and store room. This structure is of wood and is 25 x 60 feet, with one pit and necessary spur and storage tracks.

Oakland, Antioch and Eastern Construction.

The construction on the Oakland, Antioch and Eastern is of the same high class as the Oakland and Antioch with 70-pound rail and rock ballast. It is expected that very high speeds will be attained, especialy on the long tangent between Denverton and Sacramento, and all of the construction and equipment is designed for high speeds and first-class service. On about 30 miles of this section of the line catenary construction is being installed for overhead work with heavy brackets and poles. Track bonds of 0000 capacity are being installed and the line, similar to the Oakland and Antioch, is being operated at 1200 volts d.c., which is to be supplied from the Great Western Power Company; two substations of 750 kw. capacity are being installed.

The standard motor cars for through service are 55 ft. long and have express compartments in addition to a seating capacity for 50. They have an electrical



Roadbed and Cut at Point of Sharpest Curvature.

equipment of four 120 h.p. motors per car. The cars now in use on the Oakland and Antioch, as illustrated, are somewhat shorter and have 75 h.p. motors instead of 120 h.p.

Comparison of Mileage.

As an illustration of the saving in mileage from the cities reached by the Oakland and Antioch, it is interesting to examine the following table, which shows the comparative distance over this line to various stations as compared with those lines already in operation:

	O & A. and connections	——So. Pac.—— Main Line	via Martinez	via Niles	West. Pac.	Santa Fe
S. F. & Key Route Pier.....	2.6					
Key Route Pier—Shafter Avenue..	4.7					
S. F.—So. Pac. Pier.....		4	4	4		
S. F.—Richmond Pier.....						10
S. F.—Bay Point.....	38.1		42			37*
S. F.—Sacramento	91.6	90*	153	140	139	
Oakland—Sacramento	84.3*	85	148	135		
Oakland—Stockton	72.0*		97	87		79
Oakland—Bay Point.....	30.8*		39			38
Oakland—Martinez	36.8		33*			
Oakland—Concord	25.8*		39			
Oakland—Walnut Creek.....	19.8*		44			

Note.—In the above table the distances are from the foot of Market street, San Francisco, and from the center of Oakland. The mileage of the San Francisco ferry trip is 2.6 miles for the Oakland & Antioch, 4 miles for the Southern Pacific, about 5 miles for the Western Pacific, and 10 miles for the Santa Fe.

Progress of the Work.

The construction work at the present time is under the supervision of J. G. White & Co., engineers, of New York and San Francisco. The immense cut through which the sharp curve runs passes immediately beneath two towers of the Great Western Power Company. Hence it is necessary that they be removed and actual work is now being undertaken. The tower to the west carries three-phase current at 11,000 and 60,000 volts, while that to the east operates at 110,000 volts, the same being among the highest voltages now in operation.

It is interesting to note the efficient manner in which the yardage in this cut is being handled. A train of four cars, each with a carrying capacity of 1½ cu. yds., is hauled alternately into the tunnel openings shown. Two mules attached to these cars suffice to pull the empty cars to the portal of the tunnel; then by hitching the mules to the wire cable shown on the ground to the left, the journey of the cars into the tunnel is completed without any lost motion on the part of the mules. The men shown on the embankment above the portals constantly direct the lowering of material through traps until each car is loaded by gravity. When the four cars are completely loaded they are then let down to the fill below by gravity. In a word, the entire process, from the time the train leaves the embankment until its contents arrive in the fill

Tunnel Portal.

below, is accomplished entirely by gravity, as the track itself is laid on a 2.6 per cent grade. By means of an occasional blast in the embankment above sufficient dirt is loosened so that the picks in the hands of the men shown above the traps are usually able to keep a continuous train of these cars in motion.

Continuing up the grade to the summit beyond this heavy cut a picturesque side-hill construction work is encountered. In the main foreground is shown the heavy line work necessitated throughout this construction. For heaviness of cut work and permanency of design this interurban line represents more the appearance of a transcontinental railroad than that of an electric interurban. As can be seen in the figure, all the smaller cuts are being day-lighted, since this can be done much

cheaper at this time than at any future period. It also indicates the substantial and permanent character with which the work is being performed.

The tunnel, 3200 ft. in length, is progressing in satisfactory shape, although water with its inevitable slush has had to be summarily dealt with.

The haulage is accomplished by means of a mine type locomotive with Westinghouse controllers, operating at 250 volts, and with a draw bar pull of 1600 lbs. when moving 7½ miles per hour. It weighs 5½ tons and operates by means of two overhead trolley wires. Two lamps in series are located in each end for headlights.

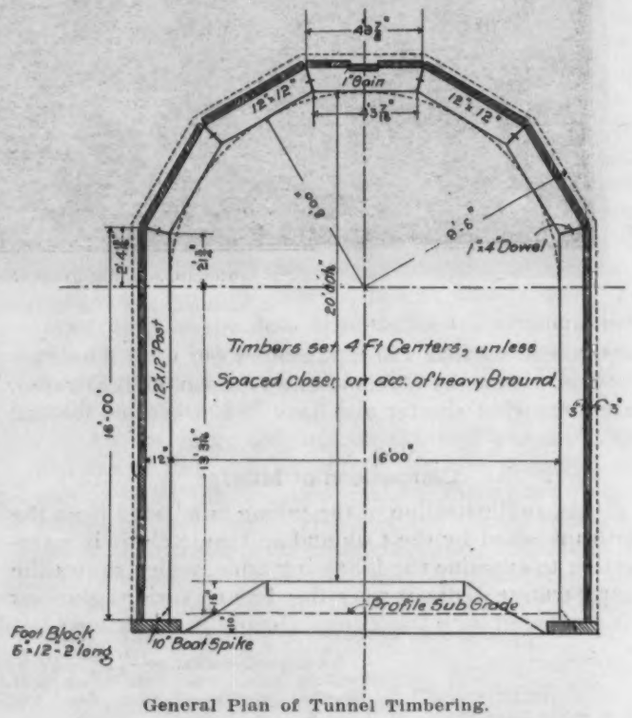
The cars, 18 in all, are made by the Western Wheeled Scraper Company of Aurora, Ill. Power is supplied from the Great Western Power Company's 11,000-volt lines, which pass nearby. In the transformer house are to be found three 25 kw. 10,000 to 480 General Electric air-cooled, oil-insulated transformers. There are also three 25 kw., 11,000 to 460 oil-insulated, air-cooled Westinghouse transformers. The station, which is of corrugated iron, is provided with ample lightning protection.

Two-Decked Jumbo Used in Tunnel Construction.

Alternating current at 440 volts is supplied to an induction motor operating at 720 r.p.m., 122 amperes, full load, which drives a General Electric direct-current generator. This generator delivers current at 250 volts when operating at 730 r.p.m. with a full load capacity of 180 amperes. The output is utilized for power in running the tunnel, fan, saw and electric traction locomotive above referred to. A three-phase, 60-cycle, 75-h.p. General Electric induction motor is used to drive, by means of a belt connection, a Sullivan air compressor which has a capacity of 600 cu. ft. of air per minute. A 15-h.p., 230-volt, 1000-r.p.m. General Electric d.c. motor is used to drive a circular cut-off saw. This saw is rigged up with the necessary guides so that the timbers are shaped to exact size for tunnel work with minimum labor.

The electric locomotive, above referred to, seems to have met every requirement put upon it. Not only is it able to handle the load shown in the picture, but also it operates with ease the big two-deck jumbo, which of necessity must climb the two per cent grade in the tunnel.

The tunnel is now, from the east end, completed for the first 450 feet, and is partially completed a total distance of 500 feet. The tunnel cross-section measures 16 x 22 ft. with 20 ft. clearance from the top of the roof. The top is timbered by means of a five-segment arch. The tunnel is well lagged wherever the material encountered necessities. Whenever the ground was such as to require crown bars and the heading was started before the portal was erected, the crown bars



General Plan of Tunnel Timbering.

project out to within six inches of the face of the portal and are thoroughly wedged between the top of the three-inch lagging and the bottom of the three-inch crown bars. The timbers are all 12 x 12 in. The lagging over the segments are always at least 6 inches wide, while the lagging beyond the post is 4 in., or if the character of the ground permitted, it is omitted.

The excavation in the tunnel amounts to 15.3 cu. yds. per lin. ft., 160 ft. of lagging is required per ft. of tunnel and 688 ft. board measure is required per set for timbering. The timbers are set 4 ft. on centers, unless closer space is required on account of heavy ground. The arch of the tunnel, which, as stated above, consists of five segments and is made of 12 x 12 in. timbers carefully sawed to proper angles and have an extreme length of 4 ft. 10 in.

TRANSMISSION POLE EFFICIENCY.

The Joint Pole Commission, representing the public utility corporations of Los Angeles reports the removal of over 120 miles of poles from the streets of the city through combination of duty for poles and removing the superfluous ones. Combinations were obtained for 4586 poles and 6135 were taken out which saved the corporations over $100,000, lowered rates for telephones, light and power and very materially added to the appearance of the streets. Since the commission was organized five years ago 700 miles of poles, representing a saving of $250,000, have been removed.

OIL FOR FROST PROTECTION.

The U. S. Weather Service in conjunction with the University of California has done much toward frost prevention. Dr. J. Elliot Coit, superintendent of the Riverside Experiment Station, gathered much valuable data during the trying period in December, 1911.

The conditions most favorable for a freeze, are as follows: (1) Clear sky, because radiation is then most rapid. (2) Very dry air, because cooling by radiation will then continue to a much lower temperature before it is checked by the heat liberated by condensation. (3) Still nights, because the air, not being mixed by wind, arranges itself in layers according to its density, and the heavier, colder air collects near the ground in contact with the trees.

Methods of Frost Prevention.

A number of methods have been suggested and tested for preventing or lessening frost injury to citrus trees. Among these the following three have proven the most practicable and effective:

(1) By Diminishing the Radiation of Heat. When any object is interposed between plants and the sky, the dark heat rays are intercepted in their upward course, and their heat made sensible. Hence any covering or other shelter over trees acts as a trap to conserve the heat gained during the day. In parts of Italy citrus trees are sometimes covered with mats of straw or other material laid on trellises. In this country it has proven too costly to cover bearing orchards, but this principle is largely used when lath screen or other shelters are erected over nursery seed bed stock. The protection secured by tying cornstalks around the bare trunks of newly planted trees is due to diminished radiation. The fact that fruits situated in the lower interior of the trees are injured to a less extent than exposed fruits is in like manner due to the trapping of radiated rays by the leaves and branches.

Conversely, clouds or a pall of smoke hanging over the orchard after sunrise will tend to intercept the heat radiated by the sun and cause the frozen fruit to thaw slowly, which is a benefit of considerable importance.

(2). By raising the Dew-Point by Adding Moisture to the Air and Thus Making Sensible the Latent Heat of Condensation at a Temperature Above the Danger Point. The deciduous fruit grower takes advantage of this principle when he maintains many smoldering fires of wet straw in his blossoming orchards. The citrus nurseryman may spray his seed bed stock, but these methods are impracticable in large bearing citrus orchards. Irrigation water, especially if warm, has proven of decided value in those orchards fortunate enough to have the water on frosty nights. The general policy of irrigating copiously during winter in the hope of protection on cold nights is open to the objection that abundant water in the soil may start new growth and render the trees more susceptible to cold than they otherwise would be.

(3) By Adding Heat Directly to the Air Through the Agency of Fires Distributed Throughout the Orchard. It has been demonstrated beyond question that this is the most successful and practical way to handle the frost problem in commercial citrus orchards. A great many devices and many kinds of fuel have been experimented with, and it is the consensus of opinion among the growers who have fought frost that the best fire so far tried is distillate oil burned in some form of sheet-iron receptacle. Experience during the last cold spell shows that the requirements of such a receptacle are as follows: Simplicity, capacity, good combustion and durability.

On account of the quality of labor available and the lack of time on frosty nights, it is very important that the receptacle should be simple and easily operated by the most obtuse workman. Pipes, cocks or valves on an oil receptacle are a serious disadvantage.

Provision must be made in the frosty areas for ten hours of effective firing. Either the receptacle must have large capacity or a sufficient number must be provided to burn in relays. Many small fires are much better than a few large ones. The amount of heat given off by pots when nearly burned out is very much less than when first lighted, hence it is wise to light the alternating receptacles before the first are burned out. Additional extra receptacles should be placed about the orchard and on the windward side for use in case of an emergency. Experience has shown that in an old, fairly thick orchard on a quiet night forty two-gallon receptacles per acre, burning slop distillate, will raise the temperature four or five degrees. With a temperature of 24 or below it will be necessary to have one two-gallon receptacle per tree burning simultanenously at the coldest period of the night in order to save a crop of lemons. It is still better to have not less than 120 per acre, forty of which can be burned early in the night, and the remaining eighty during the coldest period toward morning. The pots that are burned early in the night should be designated with a white band of paint. It often happens that the lighting of the second lot raises the temperature sufficiently high so that the first fires can be dispensed with by covering the receptacles. These same receptacles may need to be lighted again at the coldest period near morning. The white band of paint insures against error in putting out the wrong fires.

As low temperatures are liable to occur on four or five successive nights, it is necessary to have arrangements for storage of oil on the ranch near the orchards. The storage should have a capacity equal to at least five fillings of all the receptacles on the ranch. The ordinary lard pail type of pot of one-gallon capacity will burn slop distillate for about four hours when new, and a little less after repeated burnings. These pots may still have a flicker of flame after eight hours, but they give off heat effectively for only about four hours. The two-gallon heater will heat effectively for about eight or nine hours with the soot collector in place, and about five hours with the cover and soot collector removed. For small isolated orchards, where there is little or no cumulative effect of the fires, a two-gallon heater to each tree with a double row around the windward side should be provided. This applies to large bearing trees, which tend to hold the heat. With small trees still more equipment is advisable.

Results secured during the cold weather of 1912 are interesting. The experience of certain growers shows conclusively that by orchard heating properly carried on, citrus crops may be safely carried through nights when the temperature falls to 20 degrees F., at a cost which is nominal when compared to the value of the fruit.

It is true, however, that there were very many failures. By far the most of these were due to the lack of sufficient heating equipment, to save the crop during the long continued very low temperature which prevailed Christmas night, 1911. In but few cases were growers properly prepared to meet the conditions. Those who began to fire early ran out of fuel long before morning, and those who delayed firing on account of lack of fuel were in many cases unable to raise the temperature appreciably after it had once reached a very low point.

Among those who were prepared to wage a winning fight, the Linoneira Company at Santa Paula, which owns 300 acres of bearing lemons, stands out as a striking example. This company had on its lowlands an equipment of 112 coal baskets and fifty-six two-gallon oil pots to the acre. A night watchman was kept in the orchard whose duty it was to watch the thermometer in the coldest spots and arouse the assistant manager of the ranch whenever the mercury reached 30 degrees. Firing was begun with the first formation of ice in the coldest spots. It was found that it was easier to maintain a temperature of 30 degrees than to restore the heat after the mercury had once fallen much below that point. Usually only every alternate pot was lighted early in the night, and these sometimes proved sufficient, but in case the conditions warranted, the remaining pots were lighted later. In this case the extra equipment saved the Limoneira crop.

Other factors which contributed to the successful outcome on the Limoneira property were the organization of the firing force of sixty men into efficient squads, each under a foreman, and the provision of a huge concrete storage tank for oil so that all the pots could be quickly filled from tank wagons. Firing was practiced thirteen consecutive nights on this ranch. The manager states that there was consumed on this ranch during the thirteen nights of firing 45,000 gallons of distillate, 500 gallons engine distillate, 1400 gallons crude oil for lighting coal baskets and 125 tons of coal. For a total expense of $4726.00, including labor, the crop was saved on 225 acres of lemons. This amounts to $15.75 per acre.

In the light of this experience, it is plain that in order to be prepared for any emergency, the lemon grower on frosty land should be equipped with at least 100 two-gallon receptacles, and preferably 120 per acre, with a double row around the outside in case his acreage is small. He should also have storage for enough oil to fill the receptacles on five or six consecutive nights.

METHODS OF WATER GENERATION IN THE NORTHWEST.

Hydraulic Turbines.

Data has been furnished showing the use of 43 hydraulic turbines, of which 12 are vertical and 31 horizontal.

The 12 vertical turbines are in the plant of the Portland Railway, Light & Power Company, at Oregon City, and are single wheels operating normally under a 37 foot head. An interesting feature about this plant is the use made of 10 turbines of a larger diameter which are belted to 10 of the above mentioned units and are operated during periods when the head is not sufficient to generate the power required, from the smaller units. Of the 31 horizontal turbines, a large majority are either double runners, or single runners with double discharge, and operate under heads varying from 37 feet to 600 feet, the last named head being that at the plant of the City of Seattle.

The largest amount of power generated by any single unit is in the plant of the Seattle-Tacoma Power Company, where the unit generates 12,000 h.p., and the smallest is in the plant of the Washington Water Power Company, where the unit generates 90 h.p.

Very little data is at hand regarding the use of impulse wheels though the City of Seattle reports the use of two units under 600 feet head and the Seattle-Tacoma Power Company four 2500 h.p. units, each unit having six runners and two nozzles. These operate under a head of about 270 feet.

Pelton impulse wheels are used at the Electron plant. Each generator is connected to two wheels and each wheel is operated by a single nozzle under a head of 875 feet. The Lombard governors are used to control these wheels by means of deflecting nozzles.

The governing apparatus at this plant may be said to be fairly satisfactory. While not entirely so, we believe it to be more satisfactory than the governing arrangements in most hydraulic plants. On some occasions the plant has dropped the entire load of 20,000 kw. and the governors would take care of the speed in a satisfactory manner. On other occasions some of the governors have acted satisfactorily, while the performance of others was not.

Steam Turbines.

The Portland Railway, Light & Power Company have two 1500 kw. vertical four stage units and two 2000 kw. horizontal four stage units, both being of the Curtis type.

The Washington Water Power Company have one 5000 kw. vertical four stage, and one 9000 kw. vertical five stage Curtis units.

The Seattle-Tacoma Power Company have one DeLaval 300 h.p. unit.

The Seattle Electric Company has 12,000 kw. capacity in Curtis steam turbines, the units being 8000 and 4000 kw. respectively. The generators are 13,800 volt machines and operate in parallel with the Post street steam plant and the Electron water power plant.

The turbines are operated during periods of low water or overload of the water power plant. One marked effect of the steam turbines when operating in parallel with the water power plant is the improved regulation. The water wheel governors are blocked and the turbines allowed to do the regulating for the entire system. This increases the output of the water plant about 6 per cent, as impulse wheels are used and the governors control deflecting nozzles.

Steam Engines.

Only one company, the Portland Railway, Light & Power Company, reports any considerable use of steam engines, and as out of seventeen engines not more than two are the same there is nothing to indicate what might be regarded as the best practice.

The Seattle-Tacoma Power Company have one steam engine of 15,000 h.p.

LAMP EFFICIENCY.

Much information is being furnished to the layman and practicing engineer on economy in light consumption by the engineering departments of the larger manufacturing companies. The National Electric Lamp Association has recently published in Bulletin No. 101 some interesting data. The article discusses, both from the mathematical and practical standpoint, the determination of the proper time at which to discard an inefficient lamp.

The price of the lamp and the rate for energy being given the problem is to determine the operating conditions under which a given type and size of lamp will produce light most economically.

On the assumption that each lamp of a lot would live a length of time exactly equal to the average life of the lot and that the wattage and efficiency were constant throughout life, very simple algebraic expressions could be derived giving the cost of renewals per candle power and the cost of energy per candle power both in terms of the efficiency, as illustrated graphically by Fig. 1. The efficiency at which the downward slope of the renewal curve is equal to the upward slope of the energy line or at which the total cost curve is horizontal would be the efficiency at which light would be produced most economically.

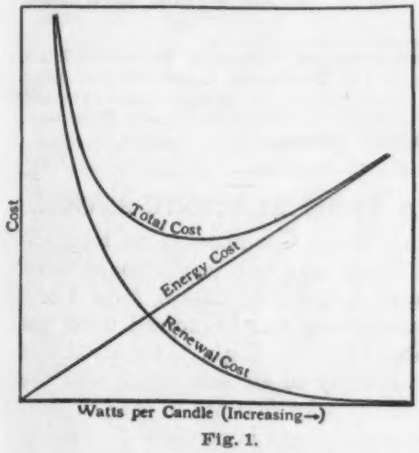


Fig. 1.

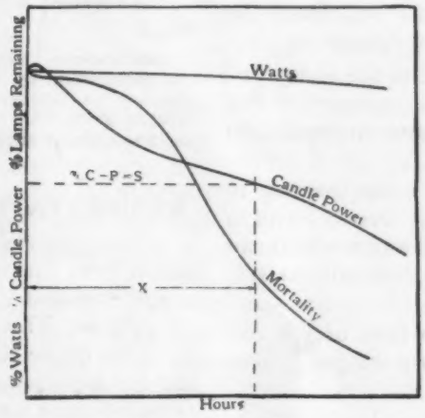


Fig. 2.

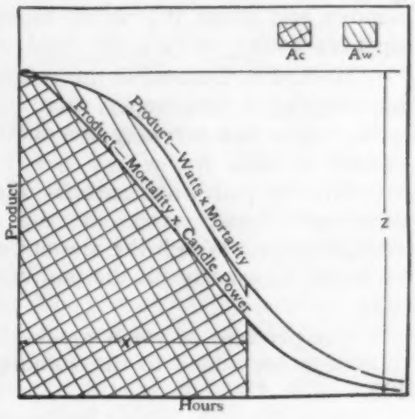


Fig. 3.

Suppose that a large installation of lamps has been put into service and that enough of this class and size of lamps have been tested to give reliable information as to the depreciation of candle power and wattage during life and as to the distribution of burn-outs with respect to time. Such data might be represented in curve form as in Fig. 2.

At any period of burning, the product of average percentage wattage and percentage mortality (percentage of lamps left burning) will give the percentage of the total initial wattage of the installation which is consumed at the period considered. Similarly the product of average percentage candle power and percentage mortality will give the percentage of the total initial candle power of the installation at the period considered. If the installation is discarded at this period the total renewal expense will be the entire cost of the whole lot of lamps.

Hence, if the areas under these two product curves (Fig. 3) are measured any given percentage of initial candle power, or smashing point, the total renewal expense, total energy consumption and total amount of light produced are determined and the total cost per unit of light can be computed for any price of lamp and rate for energy. If the areas are corrected to correspond to some other initial efficiency, the total cost per unit of light at this new efficiency can be found. The efficiency at which this total cost is a minimum is then the best efficiency for the particular smashing point considered. This best efficiency varies with the price of lamp and cost of energy, being higher (lower in the w. p. c.) for low prices of lamp and high energy later, and vice versa.

It is found that when a particular class of lamp is operated at the best efficiency there is a constant ratio between the energy and renewal elements of the total cost. The fact that this ratio is a constant at best efficiency furnishes a rapid method of calculating approximately the best efficiency.

Example:—A 40-watt "Mazda" lamp, during 1,000 hours, will consume 40 kw-hrs. At 10c per kw-hr., this energy will cost $4.00. Dividing by 5.84 (see table Ratios of Cost of Lamp to its Life), the proper renewal expense per 1,000 hours is found to be 68.5c. The list price of the 40-watt "Mazda" lamp is 70c and if burned at high efficiency, the average life is 1,000 hours, hence the ratio between renewal and energy expense per 1,000 hours is approximately correct, and the high efficiency rating is therefore approximately correct for 40-watt "Mazda" lamps when the lamps cost 70c and energy costs 10c per kw-hr.

Ratios of Cost of Lamp to Its Life.

Class of Lamp.	b-h	b-h+1	$\frac{1}{b-h+1}$	K
Carbon	4.24	5.24	.1909	1.629
Gem	4.21	5.21	.1919	1.631
Tantalum	4.21	5.21	.1919	1.631
Mazda	5.84	6.84	.1462	1.516

If the total unit cost of light is computed for various smashing points, and the best efficiency is used for each individual computation, it will be found that for some particular smashing point and corresponding best efficiency the total cost of light per unit is an absolute minimum.

A remarkable feature connected with this smashing point which gives the absolute minimum is that it does not vary with either the price of lamp or the rate for energy, but depends only upon the shapes of the characteristic performance curves of the lamp.

DETERMINATION OF VOIDS IN CONCRETE AGGREGATES.

BY CHAS. DERLETH JR. AND ARTHUR C. ALVAREZ.

Apparatus. One 1000 c.c. or 500 c.c. graduate, one balance with scoop and counterweight, one set of metric weights, one wooden measuring box, one water pail, one galvanized iron measuring cylinder with bottom inlet and tube, scale graduated to tenths of an inch, scales sensitive to one-quarter of an ounce.

Operations. The party will determine the voids in the sand, gravel and broken stone samples separately by each of the methods mentioned. Method 1 will give approximate results only where the particles are less than one-quarter inch in size, since all the air is not expelled by the entering water. It is, however, well adapted for rough determinations in the field, where special apparatus is not always at hand.

In both method 1 and method 2, immerse any aggregate which is absorbent, for thirty minutes, then remove and allow the water to drain well from the surfaces before making the void determination.

Method 1. Determine the volume of the water pail by weighing it first empty, then filled to the very rim with water, and dividing the difference in weight in pounds by 62.4.

Fill the pail with material and after shaking to cause settlement, scrape the top off evenly with a straight edge. Weigh the amount of water which can be added to exactly fill the pail and calculate its volume.

The per cent of voids equals the ratio of the volume of water added to the volume of the pail, times 100.

Method 2. Determine the volume of the cylinder by measuring its average diameter and height to the nearest tenth of an inch.

Place the funnel attached to the rubber tube which leads to the bottom of the measuring cylinder in the lower rack which is level with the bottom of the cylinder. Fill the tube and funnel with water to the bottom level of the cylinder. Fill the measuring cylinder with aggregate. Raise the funnel to the upper rack. Weigh the water which must be added: 1—to reach the top level of the aggregate if the material settles; 2—to fill the cylinder.

Calculate the per cent of voids as in method 1.

For any aggregate which settles, obtain also the ratio of the volume of water, added to reach the top level of the aggregate, to the actual volume of the settled aggregate.

Method 2 is slightly more accurate than method 1, since less air is entranced when small particles make up the aggregate. The per cent of moisture greatly influences the per cent of voids in sands. For sand and in general, method 3 will give more reliable results.

Method 3. Specific Gravity Method. Determine the specific gravity of each of the materials in the following manner: Weigh the glass graduate first empty, then half filled with water. Check the increase in weight with the volume. Weigh out about the same volume of dry aggregate, add and agitate if necessary to remove any air bubbles. Quickly note the exact rise of the water level before the material absorbs any appreciable amount of water.

The specific gravity of the material equals the weight of aggregate added, divided by the weight of displaced water.

Weigh the wooden measuring box. Fill even full with aggregate; shake to cause settlement and weigh again. Calculate the per cent of voids by using the specific gravity above obtained. If the material is not dry, its weight must be corrected for the per cent of moisture present. Determine the per cent of moisture by weighing out about 50 grams, then thoroughly drying in the oven and reweighing.

Mix thoroughly an amount of dry sand and broken stone in the proportions 1:2, by volume shaken, sufficient to slightly more than fill the wooden measuring box. Fill the box even full with this mixture, shake slightly to cause settlement, and obtain its net weight. Calculate the per cent of voids in the mixture.

Tabulate the results of the several determinations.

References. Determination of Voids. 1. Concrete—Plain and Reinforced, by Taylor and Thompson, pages 160-168. 2. A Treatise on Masonry Construction, by Baker, pages 143-146, 101-102, 91-94. 3. Bulletin 23, University of Illinois Engineering Experiment Station, by I. O. Baker.

RESUSCITATION FROM ELECTRIC SHOCK.

The first meeting of the Commission on Resuscitation from Electric Shock was held in the board room of the National Electric Light Association, New York, on Feb. 22. This commission was organized upon the initiative of the National Electric Light Association, and has for a purpose the study of electric shock and the preparation of a set of rules for first aid in case of electrical accident. The commission is composed of members of the American Medical Association, National Electric Light Association and American Institute of Electrical Engineers, as follows:

Nominated by the American Medical Association: Dr. W. B. Cannon, professor of physiology, Harvard University, chairman; Dr. George W. Crile, professor of surgery, Western Reserve University; Dr. Yandell Henderson, professor of physiology, Yale University; Dr. S. J. Meltzer, Rockefeller Institute for Medical Research, New York; Mr. W. D. Weaver, editor Electrical World, secretary. Nominated by National Electric Light Association: Dr. E. A. Spitzka, professor of general anatomy, Jefferson Medical College; Mr. W. C. L. Eglin, electrical engineer Philadelphia Electric Company. Nominated by American Institute of Electrical Engineers: Dr. Elihu Thomson, electrician, General Electric Company; Dr. A. E. Kennelly, professor of electrical engineering, Harvard University.

At the meeting in New York City the medical members of the commission unanimously advocated the Schaefer, or prone, method as the best means in the hands of laymen for maintaining respiration in victims of electric shock, and the commission formally voted to recommend this method. A chart is now being prepared which will give details of first aid in cases of electric accidents and will describe fully the method of applying artificial respiration. This chart will be issued under the auspices of the National Electric Light Association.

GRAPHICAL ANALYSIS OF THE ALTERNATING CURRENT TRANSFORMER.

BY A. L. MENZIN.

As a more complex example of the use of polar diagrams, discussed in the Feb. 17th issue of this Journal, without any reference to the wave theory of electrical phenomena, the alternating current transformer will be considered. Instead of making all the solutions in one diagram, as is customary, the various steps will be developed in different diagrams for the sake of clearness.

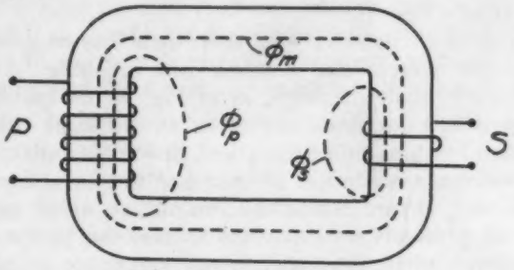


Fig. 1. The Transformer.

Fig. 1. shows the transformer diagrammatically. An impressed e.m.f. at the terminals of the primary P will produce a current through the primary coil. This will set up a magnetic field; a part of the flux will take the path ϕ_m and be interlinked with the secondary S, and a part will take the shorter path ϕ_p. The variation of the flux along ϕ_m, due to the variation of the primary current, will induce an e.m.f. in the secondary coil, and a current will flow if the secondary circuit is closed. This current will also produce magnetic flux, a part also taking the path ϕ_m and a smaller part the path ϕ_s. The flux threading the core and designated by ϕ_m is therefore the resultant of the fluxes produced by the magnetomotive forces of both primary and secondary coils. Since this flux is interlinked with both circuits it is the flux of mutual induction, while the fluxes ϕ_p and ϕ_s, being interlinked with one circuit only, constitute the self induction of primary and secondary, respectively.

The e.m.f. induced by the flux ϕ_m must be the same per turn; hence the e.m.f's. induced in primary and secondary coils must be to each other in the ratio of their respective turns. The primary induced e.m.f. plus the "drop" in the primary coil must equal the impressed e.m.f. at the primary terminals. The secondary induced e.m.f. less the drop in the secondary coils must equal the e.m.f. at the secondary terminals.

In the following discussion, whenever the unqualified terms current, e.m.f., magnetomotive force, etc., are used, the maximum values will be understood.

In Fig. 2 let the vector O — ϕ_m represent the phase and maximum value of the flux of mutual induction represented by ϕ_m in Fig. 1. Then the primary and secondary induced e.m.f. are represented by the vectors O — e_p and O — e_s, their phase being one-quarter of a period behind the flux ϕ_m and their lengths being in proportion to the ratio of the respective turns in primary and secondary coils.

Let O — a represent the phase of the resultant magnetomotive force, which leads the flux of mutual induction by the time value of the angle a O ϕ_m because of hysteresis.

Let O — I_s represent the phase and magnitude of the secondary current lagging behind the induced secondary e.m.f. by the time value of the angle e_s O I_s. Since magnetomotive force must be in phase with the current producing it, the secondary magnetomotive force is represented by O — I_s N_s.

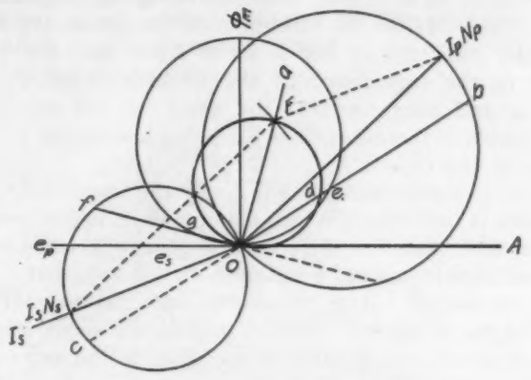


Fig. 2. Magnetomotive Forces.

If the magnitude of the primary magnetomotive force is known its phase may be determined as follows: With I_s N_s as a center and radius equal to the primary magnetomotive force, draw an arc intersecting O — a. From the point of intersection F draw a line parallel to O — I_s N_s and complete the parallelogram. The vector O — I_p N_p, then, represents the phase and maximum value of the primary magnetomotive force, for O — F is the resultant of O — I_s N_s and O — I_p N_p.

The graphs of the magnetomotive forces and the flux of mutual induction may now be obtained by circumscribing the circles about the respective vectors representing the magnitudes and phases of the maximum values. The instantaneous relationships may then be investigated.

At the time corresponding to the vector O — b, the primary magnetomotive force equals O — b and is positive, the secondary magnetomotive force equals O — c and is negative, the resultant magnetomotive force equals O — d and is positive, and the flux of mutual induction equals O — e. At the time corresponding to the vector O — f, the primary magnetomotive force is equal and opposed to the secondary magnetomotive force, the resultant magnetomotive force is zero, but the flux is O — g. Although no magnetomotive force is active, a flux exists due to the hysteresis of the transformer.

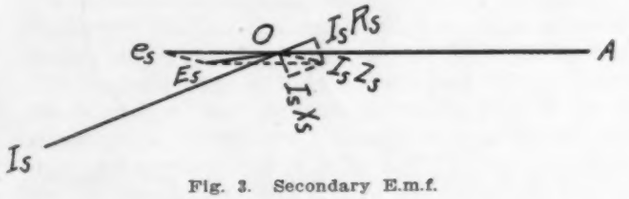


Fig. 3. Secondary E.m.f.

It is seen that, in general, the primary magnetomotive force opposes the secondary. This is the key to the self-regulating action of the constant potential transformer.

In Fig. 3 the vectors O — I_s and O — e_s are reproduced from Fig. 2. O — I_s R_s represents the phase

and magnitude of the counter e.m.f. of resistance of the secondary coils, one half-period behind the secondary current. O — $I_s X_s$ represents the phase and magnitude of the e.m.f. of self induction in the secondary coils due to the flux ϕ_s in Fig. 1. The phase and magnitude of the resultant e.m.f. of impedance, O — $I_s Z_s$, is found by drawing the parallelogram.

The e.m.f. at the terminals of the secondary must be the resultant of the induced e.m.f. and the e.m.f. due to the impedance of the secondary coils. The phase and magnitude of the e.m.f. at the secondary terminals is therefore O — E_s, being the vector sum of O — e_s and O — $I_s Z_s$.

It is seen that the e.m.f. at the secondary terminals is less than the e.m.f. induced in the secondary coils, and that this difference becomes less if the internal resistance and reactance of the secondary coils are decreased. It is also seen that the greater the lag of the secondary current behind the secondary induced e.m.f., the greater is the drop in the secondary coil.

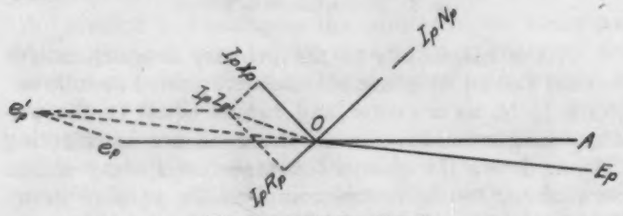


Fig. 4. Primary E.m.f.

In Fig. 4 the primary e.m.f. is calculated. The vectors O — $I_p N_p$ and O — e_p are reproduced from Fig. 2. O — $I_p R_p$ represents the counter e.m.f. of internal primary resistance, O — $I_p X_p$ represents the internal primary reactance due to the flux ϕ_p in Fig. 1. O — $I_p Z_p$ is the resultant e.m.f. of internal primary impedance found by combining the components O — $I_p R_p$ and O — $I_p X_p$. The total counter e.m.f. at the terminals of the primary must equal the vector sum of the induced e.m.f. and the e.m.f. of internal impedance, and is represented by O — e'_p. Since the impressed e.m.f. must be equal and opposed to the total counter e.m.f., the phase and maximum value of the impressed e.m.f. is represented by O — E_p, equal to O — e'_p and displaced from it by a half-period.

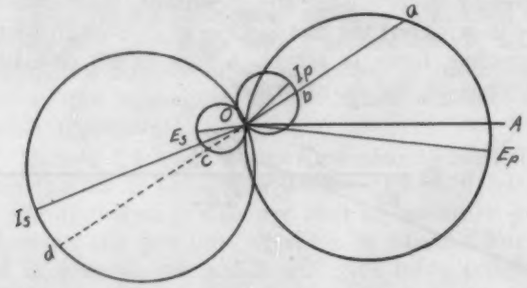


Fig. 5. Primary and Secondary E.m.f. and Currents.

Fig. 5 shows the graphs of the primary and secondary currents, the primary impressed e.m.f., and the e.m.f at the secondary terminals obtained by circumscribing circles about the vectorial diameters representing the phases and magnitudes of the maximum values reproduced from the preceding diagrams. It is seen that the secondary current lags behind the e.m.f. at the secondary terminals by the time value of the angle E_s O I_s, and that the primary current lags behind the primary impressed e.m.f. by the time value of the angle E_p O I_p.

The values of the current and e.m.f. at any instant may be determined by drawing the corresponding vector and measuring the intercepts. At the time corresponding to the vector O — a, the primary e.m.f. equals O — a, the primary current equals O — p, the scondary e.m.f. equals O — c, and the secondary current equals O — d.

Fig. 5 also shows why there is a loss of capacity when the current and e.m.f. is not in phase. If the one lags behind the other, as in Fig. 5, the maximum value of the one does not occur at the same time as the maximum value of the other, hence the power output will be less for the same maximum (or effective) e.m.f. and current, since the summation of all instantaneous products e i d t, which equals the power, is a maximum when the current and e.m.f. are in phase, that is when the power factor equals unity.

Many other peculiarities of transformer action may be seen by collecting certain of the vectorial diameters and circumscribing the corresponding graphs.

WIRELESS TELEGRAPHY OVER DESERT.

Dr. H. L. Coffman of Palm Springs, Cal., is securing estimates on the cost of installing a series of wireless telegraph stations that are to cover the upper reaches of the Conchilla desert. The plan is to establish at least five stations. One is to be located at Banning, in San Gregorio Pass. The second will be at Seven Palms on the north side of the desert. The third will be at the Palm Springs agua caliente. The fourth relay will be at Indian Wells to the south, while the fifth will be erected at Indio.

ENGINEERS' LICENSES AT LOS ANGELES.

Mayor Alexander of Los Angeles has signed the ordinance making a new percentage classifications of stationary engineer's licenses. Those of the first class may operate boilers of any power; those of the second class are limited to 500 horsepower, and those of the third class any of 100 horsepower or less. The measure had the opposition of some of the unions, but was supported by the National Association of Stationary Engineers.

POLES SHIPPED AS LUMBER.

Rates on poles and piling from Oregon points to California cities over the Southern Pacific have been declared unreasonable by the Interstate Commerce Commission to the extent that the rates exceed lumber rates between the same points. In a case decided this week, the California Pole & Piling Company of San Francisco was the principal complainant. The road charged a rate of $6 per ton form Oregon points to San Francisco. The commission decided that the lumber rate of $5 should have been charged and awarded reparation of $1376.27, with interest, to the San Francisco firm.

TURBINE LOSSES AND THEIR STUDY.[1]

BY ROBERT SIBLEY.

In a former lecture we found that there are four losses in the operation of the steam turbine; 1. Friction loss in the nozzle or other stationary guiding device. 2. Inefficient angles formed by blades of the stationary and rotating parts. 3. Friction loss due to the flow of steam through the rotating parts. 4. Mechanical losses such as friction in journals and bearings, windage and the like.

Now let us see how these different quantities may be computed and to what extent they may be obviated in the design and operation of the turbine. We saw in the first lecture on the steam turbine that the velocity of the steam emerging from the nozzle is computed by the formula $v = 223.84 \sqrt{H_1 - H_2}$, in which v is the velocity in feet per second, and H_1 and H_2 the respective total heats of the steam before entering and after leaving the nozzle. It is found in practice that about 10 per cent of the energy, $(H_1 - H_2)$, is lost in friction as the steam passes over the stationary portion, consequently all of the original energy is not available for producing the velocity of the emerging steam.

Let us suppose that m parts of unit energy are lost in this friction, then $(1 - m)$ parts are left for the production of kinetic energy and since there are $(H_1 - H_2)$ units of heat in all, we have $(1 - m)$ $(H_1 - H_2)$ units for the total production of velocity in the steam nozzle. Hence to speak more correctly, $v = 223.84 \sqrt{(1 - m)(H_1 - H_2)}$. If this quantity m has a value of 0.1, we find at once by substituting in this equation that the velocity becomes $v = 223.84 \sqrt{.9 (H_1 - H_2)}$ $\therefore v = 212.42 \sqrt{H_1 - H_2}$. This, then, gives a more accurate formula for computation in the steam turbine and constitutes the method of computing velocities when the friction loss in the nozzle is definitely known.

A most useful diagram for handling computations of turbine design, and for determining the quality of the steam in the various states of expansion in the steam turbine is that shown in Fig. 1. Such a diagram is known as the Mollier chart and is worked out on an elaborate scale in the tables and diagrams of Marks and Davis. Let us for a moment examine the extreme usefulness of this chart. We have already found definite formulas for computing the velocity of steam in the nozzle of the steam turbine. In the diagram shown in Fig. 1, entropy of steam is plotted as horizontal lines and the total heat of the steam as vertical lines, while on the diagram itself are seen lines extending upwardly to the right which are those of equal pressure, while those slanting downward to the right are those of equal steam quality.

Let us suppose that we have steam in a turbine operating under 180 lb. absolute pressure and that it exhausts into the condenser at 0.75 lb. absolute. Assuming that the steam is superheated 100 degrees F., let us see if we can determine the condition of the steam when it enters the condenser. The point A on the diagram will be seen to represent steam at 180 degrees pressure and 100 degrees superheat. Looking vertically downward to the point D we come to the line representing 0.75 lb. absolute. We read at once that the steam has a quality of 79.8 per cent. We also see that the total heat of superheated steam at A is 1255 B.t.u., while that at D is 892 B.t.u. Hence the heat drop is 363 B.t.u.

We come now to the most important question of design in the steam turbine, which is a study of the proper relationship of angles of the entering steam with the moving vanes and that of the emerging steam with the moving vanes.

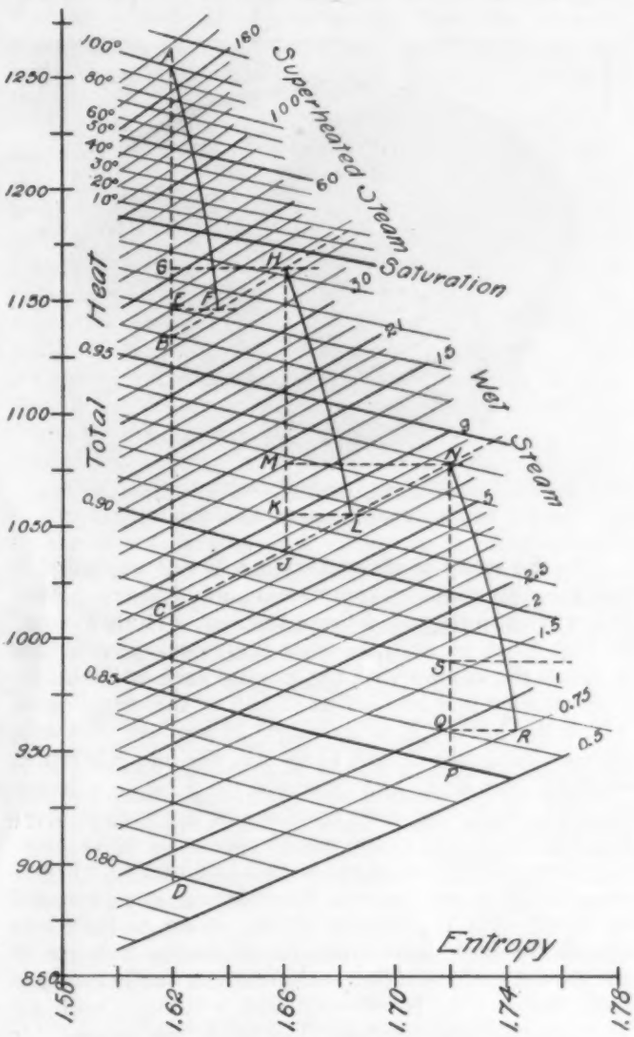


Fig. 1. The Mollier Chart or Heat-Entropy Diagram.

Let us consider an analogy for a moment. A "hold-up" fires at the engineer of an express train a bullet which travels at the rate of 60 miles an hour. The express train is also traveling at the rate of 60 miles an hour and is moving directly away from the rifle muzzle. The bullet is unable to overtake the engineer, consequently he is unharmed. If now the "hold-up" is traveling on the rear of the train and fires his shot, with an accurate aim, his shot is fatal to the engineer. The lesson to be learned from this example is the extreme care necessary in computation involving relative and absolute velocities. We may not all have our lives saved by improper velocity calculations of a "hold-up," but we shall see that it has a most important bearing in steam turbine design.

[1]This article comprises the Twenty-Second Lecture of a series appearing in these columns entitled "Primer of Applied Thermodynamics."

In Fig. 2 the steam nozzle A is emitting steam at the high velocity v against the bucket E, which is moving to the left at the rate of u ft. per second. The entering steam, which has a velocity v ft. per second, makes an angle a (shown as 20 degrees in Fig. 3) with the direction in which the bucket E is moving, consequently the velocity v may decompose itself in two velocities when moving with the vane E in an amount equal to the velocity of the vane E, which is u ft. per second, the other moving relatively along the surface of the vane E with an amount equal to V ft. per second.

Fig. 2. The Steam Turbine Nozzle.

In the study of elementary mechanics we find that this velocity v and its components u and V are related in a very simple and definite manner. Thus, looking at Fig. 3, let us draw to scale the velocity v, so that it makes the angle a with the moving vane or bucket E. The velocity u is laid off as shown in the direction in which the bucket E is moving. If now we complete the parallelogram BCDA as shown, the line AD represents in magnitude and direction the relative velocity V. In a word, if we were traveling on the vane or moving bucket E, the steam would appear to us as moving along the surface of the bucket in direction AD and equal to V ft. per second. Considering ourselves still traveling with the bucket E, the steam is forced to constantly change its direction of motion because of the curved surface of E, consequently it finally emerges from the vane at H, moving with a velocity with respect to the moving vane E of W ft. per second. It is evident that if nothing has happened to decrease the velocity of the steam as it moves along this vane, W will be equal in magnitude to V.

Assuming ourselves now, not as riding with the bucket E, but as looking at its movements as we stand nearby, let us see if we can find the absolute velocity of the emerging steam. Applying the rule just formulated from elementary mechanics, we see that the velocity of the emerging steam is made up of two components—that moving in the direction of the moving bucket E, which is u ft. per second, and that moving along the vane which is in magnitude W ft. per second. Hence the diagonal HG of the parallelogram HKGL represents the final absolute velocity in magnitude and direction and is as shown w ft. per second.

Years ago, Sir Isaac Newton announced to the world certain laws of motion which have become classics and which are regarded as the basis of the mathematics of engineering. One of these laws states "that to every action there is an equal and opposite reaction," and also "that a body in motion will continue in motion and a body at rest will continue at rest unless acted upon by some external force." Let us now apply these two simple laws and deduce at once the energy and power relationship in the turbine.

Looking again at Fig. 3, we see that the steam enters the moving bucket with a velocity of v ft. per second. This velocity makes an angle a with the moving vanes. The steam finally emerges from the moving vane, possessing a velocity of w ft. per second and making an angle b with the moving vane. Something then has happened to the moving steam in its journey through the rotating blades. In a word, a

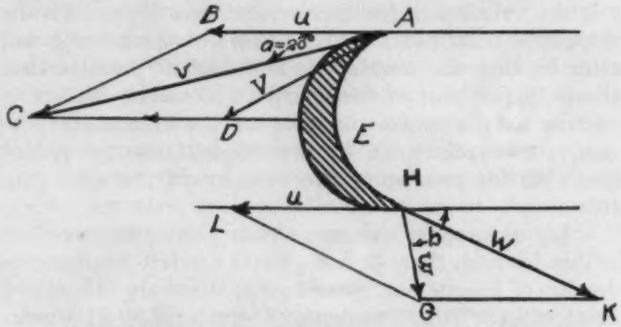


Fig. 3. The Velocity Components in Moving Blades.

force has been acting and this force is as stated by Newton, in proportion to the rate of change in this velocity. Since the component of force which goes toward useful work is in the direction of the moving bucket E, let us then find the rate of change this velocity has encountered in the direction of the moving bucket E. The steam entered with the velocity v making as we have seen an angle a with the moving vane, consequently (v cos a) is the component velocity of the entering steam in the direction of the moving vane. Since the steam leaves the moving vane with the velocity w ft. per second making the angle b with the moving vane E, the component of velocity of emerging steam in the direction of the moving vane E is (w cos b). Hence, if we subtract these two quantities we have the net change in velocity occurring every second in the direction of the moving vane. The force, then transmitted by the steam to the moving vane E, is proportional to (v cos a + w cos b). Mathematically expressed this is $F = k\ (v \cos a + w \cos b)$, in which k is constant and in engineering practice this constant is the value of $\frac{1}{g}$, where g is usually taken as 32.2.

Hence, the force acting per pound of steam is

$$F = \left(\frac{v \cos a + w \cos b}{g}\right).$$

Since work is a product of a force times the distance through which this force acts, and since the distance is evidently u ft. per sec., therefore, the useful energy per pound of steam is

$$\frac{(v \cos a + w \cos b)\, u}{g}$$

The total amount of energy supplied per pound of steam is, as we have found $(H_1 - H_2)$ heat units or $778\ (H_1 - H_2)$ ft. lb. Consequently the efficiency E from steam to buckets is

$$E = \frac{u\ (v \cos a + w \cos b)}{778 \times 32.2\ (H_1 - H_2)}$$

or

$$E = \frac{u\ (v \cos a + w \cos b)}{25051.6\ (H_1 - H_2)}$$

Let us, however, consider for a moment the efficiency of the steam due to the angular arrangement of the blades. In other words, let us not use in the denominator, as taken above, the energy of the steam before it passes through the nozzles, but rather after it has passed through and is just on the point of beating against the moving blades. We have seen that the velocity of the steam emerging from the nozzles is v ft. per second, hence the energy possessed by this emerging steam is, from elementary mechanics, found to be $\frac{v^2}{2g}$. Consequently, the efficiency of the moving blades with respect to the energy emerging from the steam nozzle is

$$E = \frac{\frac{u\ (\cos a + w \cos b)}{g}}{\frac{v^2}{2g}}$$

$$\therefore E = \frac{2u\ (v \cos a + w \cos b)}{v^2}$$

Let us now see under what conditions this efficiency may be made a maximum; in other words, under what angular velocity arrangement of the rotating parts may we get the most energy from the steam. Looking at the equation just arrived at, we see at a glance that the expression (v cos a) becomes the largest possible when a is zero, for at this point the (cos a) is unity. This means for ideal conditions, the nozzle should deliver all steam in the exact direction in which the buckets are moving, which is impracticable, but in careful design the angle a is made as small as possible.

Again the expression (w cos b) becomes the lowest when it is equal to u, for at this point the steam would drop lifeless from the moving blade. This also is impracticable, but it indicates the end toward which proper design leads. Under the angular conditions above mentioned our expression for efficiency is

$$e = \frac{2u\ (v - u)}{v^2}$$

or

$$e = \frac{2}{v^2}\ (v - u)\ u.$$

It is now interesting to see what the speed of the moving vane should be with respect to the entering velocity of steam, in order to utilize the maximum energy of the steam. In elementary calculus we find that by putting the first derivative of e with respect to u equal to zero and solving for u we shall arrive at this ideal toward which we should work. Performing this operation we have

$$\frac{de}{du} = \frac{2}{v^2}\ (v - 2u).$$

Putting

$$\frac{de}{du} = 0,$$

we have

$$v - 2u = 0, \text{ or } u = \frac{v}{2}.$$

Consequently we deduce this most important law, that to absorb all of the energy from the entering steam the moving blade should rotate with a speed equal to exactly one-half that of the entering velocity of the steam.

Let us now consider for a moment the third loss met with in the operation of the steam turbine. This loss is, as we have seen, due to friction caused by the steam rushing over the moving blades and in practice is found to be from 5 to 20 per cent. We stated above that if there were no loss, the relative exit velocity W should be equal to the relative entrance velocity V, but since there is a loss and this loss is at an average of about 10 per cent we assume in design that $W = .9V$. By taking advantage of all the angular relations now deduced, and having given the boiler and exhaust conditions of the steam, we can proceed with the computation of the velocity relations in the turbine.

The fourth consideration being that of losses due to mechanical friction cannot be computed completely by theoretical means. The only way to accurately determine the loss due to the heat in the bearings and journals, and loss due to windage and other minor quantities is by careful tests performed after the turbine is completely designed.

Thermotwisters.

1. Steam is delivered to a turbine at 180 lb. abs. with 100° F. superheat. The condenser operates at 0.5 lb. abs. What is the energy possessed by each lb. of steam leaving the turbine nozzle, assuming 10% loss in nozzle due to friction?

2. The nozzle makes an angle of 20° with the moving blades in the above turbine and the steam leaves at an angle of 30°. Assuming five stages of expansion and that the blades move with a velocity of 500 ft. per sec., what is the steam to bucket efficiency?

3. What should pressure gauges read, if inserted at each one of the above stages of expansion?

THE EFFECT OF GRAVITY.

The effect of the mountains, continents, and oceans upon the earth's attraction or gravity is the subject of an interesting report, now in press, of an investigation by the Coast and Geodetic Survey of the Department of Commerce and Labor. It has been proved, as a result of investigations by the survey of the deflections of the vertical and by similar investigations in other countries, that a condition of approximate equilibrium exists in the earth's crust as well as in its interior. By the earth's crust is meant the first hundred miles, more or less. The continents and mountain masses are not held up by the rigidity of the earth's crust, nor are the oceans thus maintained. But the land areas are floated by a defect of matter beneath them, and the ocean bottoms are depressed and held in place by an excess of matter beneath the ocean areas.

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Electric Energy for Frost Prevention

The successful campaign for frost prevention has passed through an interesting history. As early as 1895, Professor Alexander McAdie, head of the U. S. Weather Bureau at San Francisco became interested in the problem and to him is largely due the present remarkably high development in our knowledge along frost protective lines.

First came the coal bucket, which was lighted upon notification of the approach of frost by the U. S. Weather Bureau. Then the wet smudge of straw and manure was advocated to form a cloud or reflecting medium above the orchard in order to return back to earth the radiating heat rays, and thus conserve the heat in the air and soil immediately surrounding the orchard trees. Flooding with water followed with some success in protection from frost among the orange groves of Louisiana, but it had a detrimental effect in pushing forth the young shoots too early in the spring. Finally came, however, two more generally useful methods—the antifrost cover, an invention of Professor Alexander McAdie, and the oil heater. The former is a prepared paper, light in weight, and is easily thrown over the tree, thereby conserving its natural heat. The latter method, the oil heater, seems especially applicable to large trees. These oil-burning heaters are now in widespread use and have been successfully employed in raising the temperature 5 degrees, or even more at critical times, thus demonstrating their worth beyond question.

During the latter part of December of the year just closed, Southern California experienced a siege of cold weather. The period over which it lasted was record-breaking in many respects, yet those orchards which are being reared under careful and scientific management suffered but little. On another page, is told how the valuable crop of a lemon orchard of 225 acres near Santa Barbara was completely saved during this trying period for $15.75 per acre.

The data that have been collected show that the heat quantity necessary for protecting the tree and its crop is well within the financial possibility of electrical application, provided proper means can be devised to economically install the necessary apparatus. Seldom can we find an electrical load more ideally suited to the power plant than between the hours of one to seven o'clock in the morning. Indeed, the utilization of the "grave-yard" shift has long been the goal toward which the progressive power plant manager has turned his efforts.

Many different methods of electrical protection from frosts are being thought of and to a certain extent, experimented upon. The oil heater, though unquestioned now as to its accomplishing a successful protection, is a nuisance in the soot and foul gases formed. It would seem, then, that an electric process would be superior to any of our present methods, in ease of manipulation, in cleanliness, and possibly in range of control at critical times.

One orange grower during the frost of last Christmas spent $4700 for fuel oil. Here then is a great field of application for small electric heaters, or even small evaporating pans heated electrically and carefully placed so as to get a maximum heat application at the particular cold spot in the ranch. Indeed, it is reasonable to think that a movement of air—the greatest frost

preventative known—can be accomplished by electrically heating certain strata of the dead or cold air at proper points, thereby creating a chimney effect.

The whole field is new, and yet electrical application of heat in every respect would be so complete, so effective, so lucrative to the power plant owner, that it would seem of sufficient importance for an immediate systematic and detailed investigation.

Economy in Household Lamps

The layman, and quite frequently some of us who profess to know more or less about the electrical industry, frequently operate lamps not only at improper voltages, but also over a period exceeding the useful or economic life of the lamp.

Some years have passed since it was established that a slight increase in voltage causes the lamp to burn many times its natural brightness, though to its detriment, and, again, a slight reduction in the voltage causes it to be unduly lessened in light-giving qualities. The subject, then, of installing lamps of proper voltage has been pretty thoroughly covered, and cases, where improperly installed lamps are being used, are comparatively few.

The burning of lamps far beyond their useful period is, however, still the ruling sin in household economy. As long as a ray of light is given out, the lamp is held to its inefficient service, even though the consumer is unwittingly paying many times the price per actual candle power delivered that would be necessary in case a new lamp were installed.

Let us for the moment look briefly into the theory of the economic use of the lamp. It is admitted at the start that the more watts used, the more the cost of energy becomes. On the other hand, if a lamp costs a certain amount of money, say 70c, and if it is burned 1000 hours, the cost per hour is one-half that of a lamp burning but 500 hours, consequently we see that the longer a lamp is burned the smaller the lamp cost per hour. On the other hand, the longer the lamp is burned, the greater is the cost of energy. These two costs constitute the total cost of lamp service.

If now, we can find the place at which the sum of these two factors—the one continually diminishing, the other continually increasing—becomes a minimum, we have at once the proper time at which to discard the old lamp for the new. On another page in this issue will be found the results of an investigation in lamp economy. There will be found a graphical representation of the two curves above alluded to and, also, a third curve, entitled total cost of watts per candle. The point at which this curve approaches nearest to the horizontal line is evidently the smallest cost in watts per candle, hence the point of greatest economy.

The inefficient use of the lamp in the household is comparable to the wasteful use of water. The modern high class system of irrigating canals is designed to deliver practically all the water to the orchard. The inefficiency of the domestic irrigator has led to a waste of nearly 50 per cent of this water. In the modern domestic supply of electric power, the power company delivers its energy in a manner that obviates every possible loss. The consumer, ignorant or heedless of economic lamp efficiency, wastes fully 50 per cent of the energy for which he monthly pays. The broadcast agitation on the part of the lamp companies to educate the public in the economic use of lamps is highly commendable, and is resulting in thousands of happier, brightier, and yet more economically lighted American homes.

Oakland and Antioch Railway

The net-work of interurban railways in Southern California is largely responsible for the unprecedented growth in that section of our country. The Inland Empire, in and about Spokane, has built up a system of interurban railways, during recent years, which has brought to the world a second demonstration of the prosperity and development that follows the trail of the interurban.

The severe topography surrounding the bay cities of California has almost made it prohibitive in the past to make electric connection with the great valleys of the interior. Scarcely a day passes, however, that we do not read of some great reclamation project being put forth by private enterprise to reclaim the rich tule lands of the Sacramento and San Joaquin valleys.

The bay cities, comprising a population of three-quarters of a million inhabitants, portray in this fact alone, the necessity of having produce markets within easy and rapid reach. Not only, then, is the question of passenger traffic one to be considered in a pliable interurban system, but the enormous movement of fruit and produce from the interior valleys is a problem which must be solved by modern electrical tractive equipment.

It is not surprising, then, that the past few months have seen ample capital subscribed to push immediately to completion an electrical link between Oakland and the city of Sacramento, the heart of the valley of the same name. It is said that the Czar of Russia, in giving his expert opinion to a group of engineers as to the proper method of connecting two of his important cities, drew a straight line between them and ordered it built accordingly, irrespective of intervening canyons and mountain summits. The Coast Range skirting the suburbs of Oakland and Berkeley has hitherto been a barrier unsurmountable so far as a direct traffic link with the interior Contra Costa drainage is concerned. But now comes the Oakland & Antioch Railroad with its deep cuts, long tunnel, and heavy fills, and accomplishes with a substantial construction worthy that of a transcontinental railroad the piercing of this range and the interlinking of the interior subsidiary valleys hitherto long isolated from the nearby cities.

The combination car, 55 ft. in length, with four motors, each of 75 h.p., operated by two multiple control attachments, adds its word in speaking for the substantial construction and equipment being used.

The electric interurban has been known to enter a district where there dwelt but the sage brush and jack rabbit, and to leave in its trail in scarcely a year, a row of promising and prosperous hamlets. The three farmers sitting on the rail fence observing an electric train pass for the first time, are said to have consecutively exclaimed, "Thar she comes. Thar she goes. Whar?" Indeed, development follows the electric interurban so rapidly it is difficult to tell from "whar" it comes, and "whar" it goes. The thousands of prosperous communities throughout the West bear witness to the early growth and encouragement received from the busy traffic-giving electric interurban.

PERSONALS.

J. A. Herr of the sales corps of the Sprague Electric Works, is visiting the Pacific Northwest.

F. S. Pratt, vice-president of the Stone-Webster Management Association of Boston, was at Seattle last week.

C. J. Rhodin, hydraulic engineer with J. G. White & Co., is in Northern California on an engineering investigation.

John M. Klein, manager of Mathias Klein & Sons, Chicago, Ill., is making his annual trip to the Pacific Coast.

F. B. Gleason, manager of the Western Electric Company's branch, has returned to San Francisco after visiting Seattle.

J. W. White of the sales department of the Fort Wayne Electric Works, has returned to San Francisco from Los Angeles.

H. C. Goldrick, Pacific Coast manager for the Kellogg Telephone & Supply Company, spent the past week at Los Angeles.

R. S. Buck, of the firm of Sanderson & Porter, is making a tour of the San Joaquin Valley looking over the electrical engineering situation.

A. H. Babcock, chief engineer of the Southern Pacific Company's electric lines, has returned from an important business trip to New York.

Thomas Mirk, of the firm of Hunt, Mirk & Co., spent the past week at Los Angeles, and other Southern California cities, on engineering business.

Bertram M. Downs has resigned as vice-president and director of the Brookfield Glass Company, of New York, after 26 years' service with the company.

A. J. Bowie, Jr. has resigned as engineer in charge of the design of the San Francisco high pressure fire system to look after his private engineering interests.

C. B. Hurley, a contractor of Tacoma, who was for some years at the head of a gas company in that city, has been visiting San Francisco during the past week.

Dr. Thomas Addison, Pacific Coast manager of the General Electric Company, is making an extended tour of the Hawaiian Islands, accompanied by Mrs. Addison.

H. G. McMillan, who is connected with the rock drill department of the Fort Wayne Electric Works, has returned to San Francisco from a Southern California tour.

M. M. Corbin, a special agent connected with the sales department of the General Electric Company, has returned to San Francisco after visiting the factory at Schenectady, N. Y.

Wallace W. Briggs, assistant sales manager of the Westinghouse Electric and Manufacturing Company, who recently returned to San Francisco from the factory, is now at Los Angeles.

Nesbet Latta, vice-president of the Wisconsin Gas Engine Company, is visiting the Pacific Coast, having spent the past two weeks at Los Angeles and now being expected at San Francisco.

J. A. Balch is superintendent of the Honolulu Telephone & Telegraph Company and also manager of a wireless telegraph station at Honolulu. He spent the past week at San Francisco.

F. V. Bennis, supervisor of the Western Electric Company, with headquarters at New York, who spent the past ten days at San Francisco, is leaving for the East via Los Angeles, after having visited all of the branch offices on the Pacific Coast.

J. S. Thornton, the former manager of the Sonora branch of the Sierra & San Francisco Power Company, is now at Raymond, Wash., looking after the electric railway and lighting interests recently acquired by Sanderson & Porter on Willapa Harbor and Grays Harbor.

Jesse P. Churchill, one of the principal owners of the California-Oregon Power Company, is at San Francisco on business connected with the closing of the contract for a large hydroelectric unit.

Frank H. Bostwick of Denver, general Western representative of the Wellman, Seaver, Morgan Company, waterwheel manufacturers, of Cleveland, Ohio, is at San Francisco on contract business.

G. M. Tripp, superintendent of the Victoria branch of the British Columbia Railway Company, has just completed an extensive inspection tour of California electric plants, accompanied by Mrs. Tripp.

A. J. Myers, district manager of the Wagner Electric Manufacturing Company, has returned to his San Francisco office after an absence of more than a month at St. Louis and in Southern California.

J. H. Wise, assistant general manager, J. P. Jollyman, engineer of electric construction, and H. C. Vensano, civil engineer, with the Pacific Gas & Electric Company, took business trips into the interior of the State during the past week.

W. W. S. Butler, who was erroneously mentioned in these columns last week as but recently assuming control of the Western States Gas & Electric Company's Stockton properties, has been vice-president, treasurer and general manager of the company since its inception.

A. A. Birch, who has been in Australia in the interests of the automatic telephone system used by the Home Telephone Company, has just arrived at San Francisco from Melbourne, in company with J. Hasketh, who is at the head of the Australian government telegraph and telephone service. He will make a study of the operation of automatic telephones in the exchanges of this country.

P. H. Herlihy, chief engineer of the steam plant in the basement of the new Hall of Justice, at San Francisco, was severely burned about the head last Monday by an explosion of gas, which, presumably, accumulated under the boilers and was ignited by a flare-back from one of the fire boxes. E. F. Bennett, the chief electrician, had a narrow escape from serious injury by the sheet of flame and the explosion, which destroyed a partition in the boiler room.

ELECTRICAL CONTRACTORS' NOTES.

New figures are being taken for the Sacramento Armory. The former figures were $7000 too high.

The Regents' Hotel on Sutter street, between Kearny and Montgomery, San Francisco, is also being refigured. At present it looks as though this building will go ahead. The electrical work will amount to about $18,000.

Bids will be called for by Architect B. McDougal for the Standard Oil Company's new building within a few days. This building will cost in the neighborhood of $500,000. An up-to-date light and power system has been planned which will run close to $20,000 in cost.

The California State Association of Electrical Contractors is distributing to all the architects throughout the State a copy of the standard symbols for wiring plans. Although these symbols have been out for about five years and have been adopted by the American Institute of Architects, there are many of the architects throughout the State that are not familiar with them.

R. E. Warren, an electrical contractor of San Jose, who is now connected with the California Electrical Construction Company of that city, was a recent San Francisco visitor.

The San Francisco district offices of the Nernst Lamp Company and the Pittsburg Electric Specialties Company, have been removed from 88 Second street to room 203, Aronson Building.

NEW YORK JOVIAN LUNCHEON CLUB.

The New York Jovians held their usual luncheon February 21st and were honored by Mr. Henry L. Doherty, president of the Henry L. Doherty Co., the well known bankers, as speaker of the day.

Mr. Doherty's subject was "The Wage Earner as an Investor," and he placed before the Jovians a number of interesting figures, showing what could be done along investing lines by the small wage earner, and from his figures demonstrated the benefit to the entire country, if it were made possible for the wage earner to become an investor in securities, which could combine the element of safety with a fair percentage of return.

There was among the public generally, he said, a fear that the accumulated wealth of the country would, in the course of time fall into the hands of a small group of individuals, but this fear need be groundless, if it were realized what a great power the small investor as a whole could become, were they educated to save and properly invest a small portion of their income. One interesting figure which he gave as an illustration was what could be done toward the accumulation of average wealth by individuals so that $24.75 yearly, properly invested would amount in 21 years, (or in the time of a man coming of age) to $1300, the average wealth of the individual of the country, and that this saving by a father for his son would on that son coming of age amount to sufficient so that the son would be in the class of those who are assumed to have the average of wealth.

Mr. Doherty spoke of his varied experience in the electrical industry and of his experience having taught him the feasibility of applying engineering ideas to finances, and that a part of his work in life was to assist as far as he could, in the education of the great masses of our public to the necessity of saving a certain portion of their income, so that the majority of the public would in time come to control, through its savings the great proportion of accumulated wealth.

After Mr. Doherty's interesting talk, Mr. Geo. W. Elliott announced that he was requested to announce that Mr. Thomas Comerford Martin, secretary of the National Electric Light Association, had been made an honorary member of the Rejuvenated Order of the Sons of Jove.

Philip S. Dodd, chairman of the ways and means committee of the Jovian Luncheon Club, reported that a meeting of the ways and means committee had been held at which it was decided that the present form of organization was most satisfactory, and that the New York Statesman, Frank E. Watts, had reported that there were sufficient funds left from the last Jovian rejuvenation to take care of the expense of mailing cards, invitations, etc., the only expense entailed at present, and that the club could be considered in good shape financially.

He reported that the ways and means committee desired to assist in every way the membership committee, and that particularly all that was necessary to the successful maintenance and growth of the organization, was that each member secure before the next rejuvenation, one or two more members for the Jovian Order, and that if this were done there would be sufficient funds available to carry the expenses of the organization for another six months or year.

NEW CATALOGUES.

Sprague Electric Fans are attractively described in Catalogue No. 325 from the Sprague Electric Works, in a 40-page booklet printed in blue and black with handsome cover.

Folder 4224 issued by the Westinghouse Electric & Manufacturing Company describes the Type B-3 mine suspension trolley wire clamp and illustrates its application by showing complete and sectional views.

The General Electric Company, supply department, has issued the first supplement to their general supply catalogue No. 4824..

Sprague Electric Works of the General Electric Company are sending out a handsomely illustrated catalog of installation of direct and alternating current motor equipments for newspaper plants.

"The Ethics of Wire Making" is the subject of a neat booklet from The Safety Insulated Wire & Cable Company, in which are told some little known facts about cable construction and insulation. A detailed description is given of the painstaking processes through which safety ruby core passes.

BOOK REVIEWS.

Ship Wiring and Fitting. An illustration manual. By T. M. Johnson. Size, 4 x 6½ inches; 77 pages; 17 illustrations; cloth binding. Published by D. Van Nostrand Co. of New York, and for sale by the Technical Book Shop, 106 Rialto Bldg., San Francisco. Price, 75 cents.

Electricity plays an important role in the modern finish of the ocean-going ship. Effective lighting is important. To know how to accomplish not only effective lighting, but to securely and safely place the wiring on board ship is a problem unique in the electric wiring art. Iron and steel take the place of stone and bricks in material met with, while vibration, moisture and salt spray make necessary precautions different from those on land problems. This little booklet treats in a clear, concise manner all the problems of ship wiring on vessels of the size of those putting out from our Western ports and will unquestionably find a welcome place among our maritime electrical workers.

Arc Lamps and Accessory Apparatus. Electrical installation R. Geo. Davey A. M. I. E. E. Size 4x6½ inches; 190 pages; profusely illustrated; clear type; strong paper; durable cloth binding. Published by D. Van Nostrand Co., of New York and for sale by Technical Book Shop, 106 Rialto Bldg., San Francisco. Price one dollar.

The recent growing applications of electrical power supply in mill and factory make the advent of this little publication opportune in every respect. The book contains over a hundred illustrations of methods used in every phase of wiring connected with such installations as set forth in its title. The cross-sectional views shown in which wires are taken over head, underground, or beneath, the floors, are of practical application in every mill or factory. A very simple extension of the methods shown would apply to western mine wiring in many instances and thus is this booklet of much value in a field for which little published matter exists.

Short Course in Graphic Statics. For students of mechanical engineering. By William L. Cathcart and J. Irvin Chaffee. Size 5x7½ inches; 183 pages; 58 illustrations; durable cloth binding. Published by D. Van Nostrand Company of New York, and for sale by the Technical Book Shop, 106 Rialto Bldg., San Francisco, Cal. Price, $1.50.

The student of mechanical engineering often encounters problems properly falling under the heading of graphic statics. He at once turns to the standard treatises on this subject but only the deep researches of the civil engineer award him for his trouble. While it is true that the Warren girder for an overhead crane, the walking beam of an engine fall under this head the far more numerous problems encountered may be completely solved by the general applications of the force and equilibrium polyphase. The little treatise as titled above covers such problems as needed by the mechanical engineer and consequently it will be a welcome stranger for his book shelf. The authors, both of high standing in the society of naval architects and marine engineering, speak throughout its nine score pages, with the stamp of experience in matters they attempt to cover.

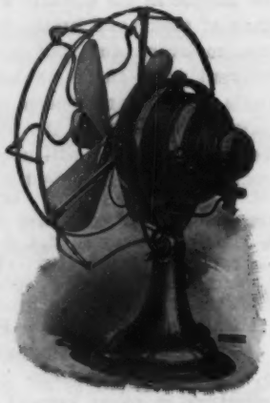
INDUSTRIAL

GENERAL ELECTRC FANS FOR 1912.

The General Electric line of fans for 1912 covers both desk and oscillating types in the 8, 12 and 16 in. sizes, direct current, and all frequencies alternating current. The standard voltages are carried in stock; odd voltages up to 250 volts may be furnished on order in any rating. The 8 in. fan is not furnished for frequencies above 60 cycles.

This line of motors follows in appearance and general features of construction the models of the preceding year. In many important details, however, decided improvements and refinements in design have been incorporated. The entire line of fans for 1912 has self-aligning ball-seated bearings with ample wick lubrication and definite oil deflectors and passages for the return of grease from the shaft to the grease cup. The attachment of the base plate has been much improved, as it is held on by one screw and the fibre insulating plate is reinforced by a thin steel plate. All sizes and frequencies of alternating current motors are of the induction type, free from moving contacts or brushes, furnished

8-in. A. C. Fan
(Desk and Bracket Type)



8-in. Oscillating Fan
(Desk and Bracket Type)

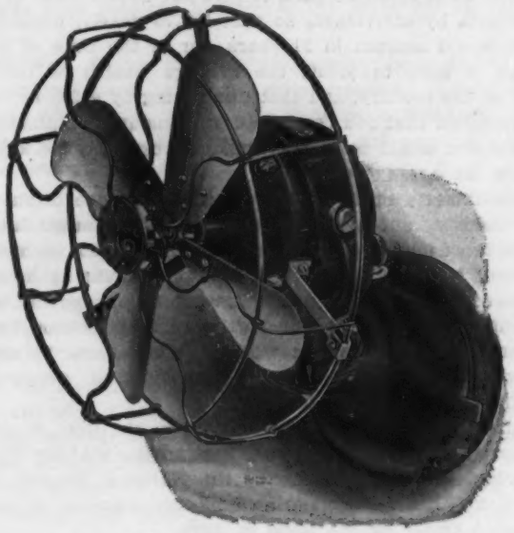
with a resistance reactance type of winding, having an extra resistance wound in one phase of the field and external reactance in another phase. This gives not only good starting torque, but when left in circuit gives an efficient winding and a flexible torque speed characteristic, permitting these motors to be controlled to a very low speed and still first-class starting characteristics to be obtained without any centrifugal switch or change in connection between starting and running conditions. This feature has been used in the main from two to three years, but only during the past year has the proportion of windings been worked out to perfection so as to give the very best results.

The oscillating motors have a positive oscillating mechanism with worm and gear speed reduction, using accurate die cast parts for the frame work. In the main features, there are duplicates of the mechanisms which gave unqualified success last season. Detail changes have been made, however, in the construction of the various bearings throughout on oscillating mechanism so that the dripping of oil or grease is either absolutely prevented, or, wherever this is impossible, a chamber is provided for catching and storing the drip. The 12 and 16 in. oscillators have two angles of oscillation and a simple gear change device which will give either the oscillating position, a locked position or a free position of the fan body. The 8 in. motor may be varied in width of oscillation from zero to the maximum.

The 12 in. 6-blade residence fans are especially designed for residence and hospital use where a quiet running fan giving a moderate breeze is desired. The 12 in. and 16 in. 4-blade fans deliver a stronger breeze than the residence fans and are for service in large offices, stores and public places. The motors are provided with switches which permit three speeds, thus providing regulation for all purposes.

SATISFACTORY TEST ON HIGH PRESSURE PUMPING PLANT.

The City Engineer of San Francisco reports that the quick steaming test of the boilers and the six-hour test of the entire mechanical equipment in the new pumping station at Second and Townsend streets have been satisfactorily completed. The contractor (Chas. C. Moore & Co. Inc., engineers) was required to guarantee that the efficiency of the boilers at rated capacity would not be less than 79 per cent; that they



12-in. 4-blade Fan (Desk or Bracket Type).

would be capable of carrying an overload of not less than 75 per cent continuously; that the fuel required to hold one boiler under steam would not exceed 5 per cent of the fuel required to operate that boiler at its rated capacity, and that steam could be raised on any boiler from cold water to 200 pounds steam pressure in thirty minutes. The efficiency of the boilers at rated capacity is 80.11 per cent.

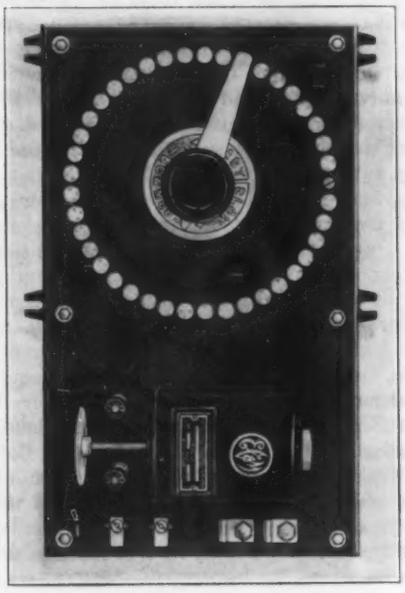
One boiler was operated for ten hours at an overload of 82.6 per cent without injury to it or its setting. The oil used to hold one boiler under steam for twenty-four hours was 1.57 per cent of the quantity required to operate it at its rated capacity. Preliminary tests on the quick steaming capacity of one boiler showed that it could be fired in less than 25 minutes, and therefore in making the official test an attempt was made to fire an entire battery of boilers. Steam was raised in one boiler of the battery in 27 minutes and 32 seconds and in the other in 29 minutes and 51½ seconds.

IMPROVED CLOTH TAPE.

The Westinghouse Electric & Manufacturing Company has recently placed on the market a bias cut, treated cloth tape, which is made under a new process and for which some very satisfactory characteristics are claimed. It can be used as continuous tape, having a good tensile strength throughout its entire length, or may be divided into four-foot lengths by tearing or without the use of any cutting tool. Another advantageous feature is the absence of any sewed seams which, when present, have to be cut to make a neat job.

E. C. & M. MOTOR FIELD RHEOSTATS.

The Electric Controller & Manufacturing Company, Cleveland, Ohio., has recently placed on the market a new line of motor field rheostats for varying the speed of adjustable speed, shunt and compound direct current motors. The manufacturers claim the following features of design to be of important value. The construction is fire-proof throughout; the face carrying the arms and contacts is of the best quality Monson slate with beveled edges and oil finish, the resistance units consist of small cast iron grids insulated with asbestos and wound with resistance wires, these units being carried by the slate and fastened directly to the contacts; the resistance wire has an unusually low temperature coefficient so that the resistance of the rheostat—for any one setting—does not increase with heating and thereby alter the speed of the motor which it regulates, an ornamental dial plate carrying the words fast and slow, indicates at a glance which way to turn the rheostat handle to obtain the desired change in motor speed, by removing the four corner bolts the slate carrying the resistance contacts and arm, can be readily removed from the case; any one resistance unit may be removed and replaced without disturbing adjacent ones.



Improved Field Rheostat Control.

An extremely interesting and valuable adjunct to these rheostats is what has been designated the field rheostat relay. It is well known that a shunt or compound wound motor should be started from rest will full field strength and, in fact, if the shunt field is weakened to a large extent, it may be impossible to accelerate the motor, because of insufficient torque, prohibitive sparking at the commutator, or such a large volume of current that fuses and circuit breakers would be blown. It has, therefore, become the preferred practice, to return the rheostat handle to position of full field strength, every time the motor is started. The field rheostat relay has been developed to prevent starting the motor with a weakened field.

LARGER QUARTERS FOR THE H. W. JOHNS-MANVILLE COMPANY IN PITTSBURG.

The rapidly increasing demand in Pittsburg and vicinity for the asbestos, magnesia and other products of the H. W. Johns-Mansville Company, has necessitated a move from their present location in Liberty avenue, above Ninth street, to larger quarters. After January 24th, 1912, the Pittsburgh branch of the H. W. Johns-Manville Company will therefore occupy the entire eight-story stone, reinforced concrete and steel building at the northeast corner of Wood street and First avenue, which has been leased by them for a term of years.

"VICTOR" INSULATOR SALES.

An item of interest regarding "Victor" insulators, showing the favor they are meeting with electrical engineers generally, is contained in an announcement received from the Locke Insulator Manufacturing Company of Victor, N. Y., to the effect that during the last few months they have closed contracts for their suspension types of transmission insulators as follows:

	Volts.
New England Power Co., Mass	66,000
Mexican Northern Power Co., Mexico	110,000
Southern California Edison Co	66,000
Puebla Tramway, Light & Power Co., Mexico	110,000
Cia Beneficiadora de Pozos, Mexico	60,000
Tri-City Railway and Light Co., Iowa	33,000

Pierson, Roeding & Co., of 118 New Montgomery street, San Francisco, with branch offices in Seattle, Portland and Los Angeles are the Pacific Coast agents for the "Victor" line of insulators.

GASOLINE ELECTRIC TOOL CAR.

The latest thing in railroading is the use of a gasoline electric tool car which is really a gasoline automobile running on the rails like a hand car and carrying an electric generator to operate the electric tools which have to a great extent superseded manual labor on the Rock Island Railroad. The motive power for the car is supplied by a 30 h.p. gasoline engine, and the electric power is furnished by a 6.5 kilowatt Crocker-Wheeler generator. The electric tools which it is designated to operate are two electric spike screwing machines, six electric drills, an electric saw for rails, and portable emery wheels. This is the equipment carried on each car.

If necessary this railroad automobile can pull additional cars or tenders to carry spikes, extra cable, or additional tools and men. From 1¾ to 2 seconds' time only is required to drive a spike with the spike screwing machine, as against 8 to 10 minutes per man driving one spike by hand in the old way. It has been found that soft wood ties can be utilized with the same degree of safety as hardwood by using screw spikes, and curve troubles are largely eliminated. The constant replacing of loosened drive spikes in ties is avoided, and there is consequently less rotting of ties caused by spike holes. Extra lengths of cable are carried with plug-in switches every twenty feet so that the electric tools can be used as far as a quarter of a mile from the car.

TRADE NOTES.

Hunt, Mirk & Co., agents for the Westinghouse Machine Company, have sold to the Los Angeles Gas & Electric Corporation an additional 5000-kw. Westinghouse-Parsons turbo generator. This steam turbine can be operated at either 50 or 60 cycles, and it is the third of the same make purchased for the power station on Alameda street, Los Angeles. The two units that have been installed already are of 3000 kw. and 4000 kw., respectively.

The General Electric Company reports a sale of a high-pressure steam turbine to the Stimson Mill Company of Seattle. The equipment is described as follows: One A. T. B. 4, 1563 k.v.a. (1250 kw.-8. pf.) 1800 r.p.m., 480 v., 3 phase, 60 cycle, horizontal, condensing Curtis turbine generating set, arranged for 150 lbs. steam pressure with 2 inches absolute back pressure. A Curtis turbine exciter set rated as C. C. 4, 75 kw., 3300 r.p.m., 125 v., non-condensing, is also included in the contract.

NEWS NOTES

INCORPORATIONS.

SAN FRANCISCO, CAL.—The Roseville Water Company; $200,000, shares $100 each, subscribed $300, by F. M. Ray, H. L. Simon and H. G. Luhisen.

SALINAS, CAL.—The Salinas Valley Water Company; $100,000, shares $100 each, subscribed $500, by C. S. Goodrich, J. T. Piggott, G. O'Connor and H. G. Hill, all of San Francisco.

SANTA BARBARA, CAL.—The Santa Barbara and Suburban Railroad has filed articles of incorporation with a capital stock of $750,000, for the purpose of taking over the Santa Barbara Consolidated Railroad Company, under the proposed new franchise.

SAN DIEGO, CAL.—Consumers in various sections of La Mesa depending on the Cuyamaca Water Company for their water, have decided to organize a company for the purpose of pumping a supply from the bed of the San Diego river east of Lakeside. It will be known as the Capitan Water Company, and have a capitalization of $90,000.

SAN FRANCISCO, CAL.—Articles of incorporation have been filed by the Universal Electric & Gas Company, the stated purpose of which is to sell gas and electric current to the people of San Francisco and other California cities. The capital stock is fixed at $5,000,000, of which Rudolph Spreckels of San Francisco and Claus A. Spreckels of New York each own $2,499,850. The remainder of the stock is distributed into three $100 shares to J. H. Sanford and Frank Herrold of San Francisco and P. S. Scales of San Mateo.

TRANSMISSION.

SEATTLE, WASH.—Jenkins & Jones, Hinckley building, were awarded the contract at $5985 for the construction of the power house at Sedro-Woolley. Saunders & Lawton, Alaska building, are the architects.

CATHLAMET, WASH.—W. J. Haycox and associates have been granted a twenty-five-year franchise by the City Council. The company will utilize the immense water power of the Elocoman River for generating electricity.

CALDWELL, IDAHO.—The Mainland interests and the Beaver River Power Company have secured identical franchises to deliver light and power in this city. It is thought the Mainlands will secure the W. R. Sebree plant.

WEED, CAL.—The California-Oregon Electric Light & Power Company has built a sub-station in Weed and is busy putting up the lines. It is using five wires and is about ready to turn on the power. The Weed Lumber Company will take about 600 h.p., but will not use it for more than a month yet.

SEATTLE, WASH.—A $12,000,000 mortgage was placed on record last week by the Old Colony Trust Company of Boston. The mortgage was given by the Puget Sound Traction, Light & Power Company, and covers all the real estate, personal property, rights, privileges, easements, licenses, franchises and other assets of the companies which are to be merged under the name of a $40,000,000 corporation. The mortgage was given for the purpose of enabling the company to issue two-year 5 per cent gold mortgage notes.

BUTTE, MONT.—The shareholders of the Butte Electric & Power Company has approved the deal for the purchase of the properties of the United Missouri River Power Company, which has been in the hands of reorganizers. The General Electric Company interests are back of the purchase which has had a bullish effect on the stock of the Butte company, the price having risen from 114 to 125. A big extension of the business of the company into a wide extent of territory about Butte is expected to result, the enlarged company giving the combined concerns almost double the capacity of the old.

SPOKANE, Wash.—The Lewis County Power Co. has been formed in Idaho by A. Welch and R. B. Montague of Portland, Ore., to develop 125,000 horsepower on the Salmon River, the plant, installation and transmission lines, representing an investment of $3,000,000. Construction work is to begin within 90 days and pushed to completion. The filings made at Nez Perce, county seat of Lewis County, on February 23, show the power sites acquired is the same as was located by the Lewiston & Southern Electric Railway Company several years ago, when it was planned to build an electric road from Lewiston to Grangeville. The driving of a 4,000-foot tunnel through a narrow ridge will provide a fall of 200 feet and empties the water again in the river at a point about seven miles below the point of intake. The initial plans provide for the driving of a tunnel through the ridge that will carry sufficient power to develop 40,000 horsepower at the beginning and the further development will be secured by the driving of a second tunnel or the enlargement of the first one. The completion of the plans will develop the 125,000 horsepower at a cost of $24 per horsepower, these estimates providing for the construction of the 200-foot dam across Salmon River at the point of intake, the driving of the necessary tunnels, the installation of the electrical equipment and the construction of the transmission lines. Mr. Welch and associates became interested in the central Idaho country a year ago, when the Nez Perce Power & Light Company was acquired. Transmission lines have since been extended to Ilo, Vollmer and Kamiah and representatives of the company have investigated every possible site on the Clearwater, Salmon and Snake rivers with a view of locating the big plant promised at the time the investment was first made.

TRANSPORTATION.

SPOKANE, WASH.—The Inland Traction Company will build two miles of road from Millwood to Irvin this spring.

BOZEMAN, MONT.—Preliminary surveys for an electric line from the mouth of Dry Creek to Bozeman are being made.

ROUNDUP, MONT.—The citizens have subscribed $11,000 toward construction of electric line from here to the coal camps.

BELLINGHAM, WASH.—The Bellingham-Skagit Company has obtained a franchise for 50 years to use streets here for its interuban line.

OLYMPIA, WASH.—The Olympia Terminal Railroad will soon start building to Tumwater, having secured a franchise from the latter city.

SEATTLE, WASH.—R. S. Terhune, president of Seattle Electric Company, states that the construction work on their line from Factoria to Issaquah will begin by April 1st.

WENATCHEE, WASH.—The Wenatchee Valley Railway & Power Company is asking a franchise to operate a suburban road. If it gets the franchise work will start in 90 days.

OAKLAND, CAL.—The new Southern Pacific Eighteenth street electric system, connecting the Fourteenth street terminus of the narrow gauge line with the main line at the Sixteenth street depot and thence to the mole, will be completed and ready for operation within two weeks according to officials of that company.

CALDWELL, IDAHO.—The electric line between here and Nampa is being built. The extension from the lower dam to Snake river is being surveyed. This line will tap the Gem irrigation project.

SANTA CLARA, CAL.—The Peninsular Railway Company has been granted a franchise for a period of 50 years to construct, operate and maintain a standard gauge electric railroad in this town.

RICHMOND, CAL.—H. C. Cutting has presented a petition to the City Council asking for a petition for a street car franchise the entire length of Cutting Boulevard, with branches to other sections.

VANCOUVER, WASH.—The Washington-Oregon Corporation has secured a franchise from the government to build its trolley line through the barrack grounds. The line will be part of the line from Vancouver to Puget Sound.

SAN FRANCISCO, CAL.—Two more blocks of the Geary street railway municipal bonds, aggregating $70,000, have been disposed of by Treasurer J. E. McDougald, leaving but $143,000 worth in the hands of the treasurer out of the original $400,000 issue. The Federal Trust Company and the Bank of Italy were the purchasers, the transaction being made for clients.

SPOKANE, WASH.—Contracts will be let within 30 days for the construction of 63 miles of electric railway for the Oregon and Southern Railway Company, according to an announcement made by the officers of the company. The company plans to build 181 miles of railroad in Oregon between Ashland, Roseburg and Marshfield. It is declared that surveys and profile maps are already complete. The contract, according to the announcement, calls for completion of the first 63 miles of road by Dec. 1.

SACRAMENTO, CAL.—The Central California Traction Company and the Northern Electric Company are entering into an agreement for the establishment of a joint freight agency. The hearquarters will be in the Northern Electric freight office on M street, between Second and Third, near the west approach to the new electric bridge. The traction people will maintain their freight headquarters on X street for the purpose of handling carload lots, but smaller shipments of freight will be handled through the Northern Electric depot.

RICHMOND, CAL.—The Southern Pacific Company has decided upon the electrification of its lines from Berkeley to Richmond and from San Leandro through Haywards to Niles. According to the estimates made by the S. P. engineers, the work of electrification between Berkeley and Richmond can be completed this year; that between San Leandro and Niles by next spring. Train service between these points is to be doubled and the time will be practically cut in two. The present plans for the work on the Berkeley-Richmond and San Leandro lines call for the beginning of activities within the next sixty days. The Berkeley-Richmond work will be started first. The electrification of the line from Melrose to San Leandro is now nearing completion and just as soon as it is finished work on the extension of the electrical work on from San Leandro down through Decoto into Niles will be instituted. The Oakland-Berkeley lines are already electrified, and it is the plan of the railroad company to have through electric trains between Oakland and Richmond in operation by November at the very latest.

SAN FRANCISCO, CAL.—The Supevisors' public utilities committee has postponed action two weeks on Bancroft's proposal that the United Railroads be directed to route its Sutter street cars down the inner Market street tracks to the ferry. Chairman Vogelsang says that the committee and the United Railroads are considering an adjustment of differences. The company will abandon the injunction proceedings which have for so long prevented the construction of the roadbed on Geary street beyond Thirty-third avenue, and will take no steps of this kind to interfere with the city's road either on lower Market street or elsewhere. When cross-town feeders shall come to be planned for the municipal road the big private corporation is also to see to it that no impediments are raised. In return for this, the company wants leave to run its Sutter street cars to the ferries on the outer tracks on Market street, using the same jointly with the city's Geary street line. As the Sutter street franchise proper does not expire until 1929 the agreement in question will mean a virtual extension of the lapsed Market street privilege for 17 years.

ILLUMINATION.

OXNARD, CAL.—The municipal light and water bond question will come up before the Oxnard voters on April 5.

VALLEJO, CAL.—An ordinance fixing electric light rates at 10c per 1000 watts, with a 20 per cent discount if paid before the 15th of the month has been adopted.

PENDLETON, ORE.—The City Council is investigating a power site for a municipality owned electric plant. The site being considered is on the Walla Walla River a short distance below Freewater.

RIALTO, CAL.—Sealed bids will be received up to April 2d for a franchise granting the right to construct and for a period of 50 years to maintain and operate power lines along the streets and thoroughfares of this city.

DALLAS, ORE.—Prospects for the establishment of a factory in Dallas for the manufacture of an improved form of incandescent electric light socket are extremely favorable, according to C. W. Minnich, manager of the newly organized Adjustable Electric Socket Company of this city.

BAKERSFIELD, CAL.—The San Joaquin Light & Power Company has applied for a 40-year franchise to erect and lay poles and wires for transmitting electric light, heat and power on public highways in the county of Kern. Sealed bids will be received for the sale of said franchise up to March 22.

SAN JOSE, CAL.—A construction crew of 100 men are at work installing a trunk line for the Sierra and San Francisco Power Company into San Jose, where agents have been busy for several weeks signing contracts for light and power W. L. McKinley, local agent for the concern, says that he will be in a position to serve patrons here within 90 days.

NAPA, CAL.—The City Council has awarded to the Pacific Gas & Electric Company the contract to light the streets of Napa from March 1, 1912, to September 1, 1912, it being the only bidder. The Great Western Power Company was awarded the contract for one year after September 1, its bid being in some respects one-half that of the Pacific Gas & Electric Company.

SANTA ROSA, CAL.—The bid of the Great Western Power Company to furnish light and pump water for the municipal water works under a five-year contract at $1150 per month has been accepted by the City Council. The contract is effective July 1. The Pacific Gas & Electric Company has been lighting the city for 15 years. Its bid for the new contract was $1370 per month for a five-year term.

PORTLAND, ORE.—Plans for the establishment of a big gas and fuel manufacturing plant near the Government moorings, about one mile above Linnton, are under way by the Portland Gas & Coke Company. The removal of the plant to the new site will require the laying of several miles of main gas conduits. The distributing plants on both the East Side and West Sides will not be affected by the removal of the main plant outside of the city limits.

OAKLAND, CAL.—The following is the report filed with the City Council by the Pacific Gas & Electric Company: Receipts—gas sales, $1,025,181.79; electric sales, $1,032,089.89; total, $2,057,271.68. Costs—operation, gas plant, $628,098.16; electric plant, $832,465.91; total, $1,460,564.07; profit on gas and electric sales, $596,707.61; other net profits, $14,245.28; total net profit, $610,952.89. Value of assets used in company's business in furnishing gas and electricity to the city of Oakland and its inhabitants: Gas plant valuation, Dec. 31, 1911, $3,998,951; electric plant, Dec. 31, $3,196,483; total plant valuation, $7,195,434; stores and supplies, $186,305.16; accounts receivable, less customers' advance payments, $93,590.58; petty cash, $3000; total $7,478,329.72.

OLYMPIA, WASH.—Sweeping charges are filed against the public service corporations of Pasco by J. H. Sylvester, mayor, in a complaint entered with the Public Service Commission. The Pacific Power & Light Company and the Twin City Telephone Company are made defendants, and it is charged that the rates for municipal light and water are exorbitant; that the company has refused to install a modern system in place of the old arc lights, as provided in the franchise; that the water system is inadequate, no pressure being available for fire fighting, and that the water is likely to cause contagion because of impure matter. The complaint cites that the telephone system, its station facilities and instruments are inadequate for the city.

TELEPHONE AND TELEGRAPH.

KAMIAH, IDAHO.—The Pacific Telephone & Telegraph Company has secured a franchise to operate in Kamiah.

CHEHALIS, WASH.—A telephone franchise has been given E. E. Coons and W. T. Justice for the Highland valley line.

PORTLAND. ORE.—The Pacific Telephone & Telegraph Company is ready to commence construction of a 14 story fireproof building to cost $500,000 at Seventh and Oak streets.

SEDRO-WOOLEY, WASH.—The Pacific Telephone & Telegraph Company is building a line from here to connect with the main line at Lawrence. They will also build a line south to Arlington.

SEATTLE, WASH.—Complete absorption of the Independent Telephone Company by the Pacific Telephone & Telegraph Company has been announced by Vice-President and General Manager E. C. Bradley of the latter company. Operation under one system is to begin as soon as the physical construction work consolidating the two plants can be completed. The Pacific company agrees not to raise its present schedule of rates for a period of two years, pending an exhaustive investigation of the whole telephone situation. This arrangement is subject to the approval of the State Public Service Commission.

SEATTLE, WASH.—Within a few days the Postal Telegraph Company will have in operation a long-distance telephone circuit with Spokane, and plans are being made for a long distance circuit between Seattle and Portland. The Postal Company is entering into the telephone business extensively and all new telegraph wires are strung so that they can be used for simultaneous telegraphing and telephoning. V. V. Stevenson, division electrical engineer of the company, with headquarters in San Francisco, is now in the city awaiting the arrival of equipment required for the Seattle-Spokane telephone circuit, and says that it is due to arrive any day and immediately thereafter the line will be opened for use.

SALEM, ORE.—Through an agreement reached following a conference between Harrison Allen, representing the Pacific States Telephone & Telegraph Company, and Attorney General Crawford and State Treasurer Kay, that company will pay into the coffers of the State approximately $110,000 for gross earnings taxes up to 1910 and probably about $30,000 more for 1911. Under the agreement the State will remit penalties amounting to about $12,000 or $13,000, but stood pat to collect the interest, which is over twice as much as the penalties. The State Treasurer's office has not compiled the exact figures. This agreement is a tacit admission on the part of the telephone company that the gross earnings act, passed by the people at the general election in 1906, was not repealed by implication by the general tax code of 1907 or the law creating a State Board of Tax Commissioners in 1909, although it has been so considered by some attorneys. It is estimated that the decision in the United States Supreme Court against the telephone company will further mean annual taxes from these companies collectively over $100,000. The gross earnings law called for imposition of a tax of 2 per cent annually on the gross earnings of certain public service corporations.

WATERWORKS.

BUTTE FALLS, ORE.—The city has voted $10,000 in bonds for the construction of a first class gravity water system.

HERBER, CAL.—Owners of the new townsite of Herber are planning to install a domestic water system in the near future.

SANTA ANA, CAL.—The Board of Trustees will advertise at once for the construction of an auxiliary water system. A concrete reservoir and cast iron mains will be built.

SACRAMENTO, CAL.—A few more details of the project of the United Water & Power Company to supply the city with pure mountain water accumulated in a reservoir near Gold Run were supplied to the water committee of the City Trustees this week by James D. Stewart and Engineer W. P. Ireland, representing the water company. The company offers to pipe the water to Sacramento in two large lines of concrete pipes for $2,500,000, and place at the city's disposal from 20,000,000 to 100,000,000 gallons a day. A system of cross pipes between the main lines, a mile apart, is promised so that the water supply shall not be impeded in case of a break in the line.

The water will be stored near Gold Run and carried to a distributing reservoir at Roseville. A site will be furnished for the city of Sacramento to build a filtration plant near the reservoir. Double lines of 66-inch concrete pipes will carry the water to 12th street bridge and under the American River. All pipes will be underground. The water supply will be drawn from the filtration plant. The two proposals submitted by the water company were: The United Water & Power Company will construct the double pipe line and tunnels specified above, the pipes to be of reinforced concrete six inches thick and the tunnels to be lined with reinforced concrete 12 inches thick and will deliver to the city of Sacramento, said pipe line and tunnels, a site for filtration plant and a permanent right to any amount of water from 20,000,000 gallons per 24 hours to 100,000,000 gallons per 24 hours, all for the sum of $2,500,000. The United Water & Power Company will construct the double pipe line and concrete lined tunnels specified above, the pipes to be constructed of riveted and dipped steel, and will deliver to the city of Sacramento, said pipe line and tunnels, a site for filtration plant and a permanent right to any amount of water from 20,000,000 gallons to 100,000,000 gallons per 24 hours, all for the sum of $3,000,000. All surveys, plans, engineering and construction work will be done by the United Water & Power Company, under the general supervision of the city engineer. If surveys are started this spring the entire work can be completed and the water will be available by July 1, 1914.